Why Not Tax It? The Effects of Property Taxes on House Prices and Homeownership

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Abstract

Owner-occupied housing units are exempt from property taxes in many countries. How does this exemption affect house prices, homeownership, and welfare? And if owner-occupied housing were taxed, should the tax be progressive? To address these questions, I develop a life-cycle model of homeownership with heterogeneous agents. The model is calibrated to the Italian housing market, where owner-occupied houses are exempt from property taxes, and these are based on cadastral values that understate market values for expensive properties, creating a regressive property tax system. The results indicate that eliminating only the exemption increases property tax revenues by over 0.9 percentage points of GDP but reduces homeownership by 2.6 percentage points. However, applying a proportional or progressive property tax rate offsets the homeownership decline while maintaining revenue levels. The reform benefits new generations' welfare, though it reduces the average welfare of households existing at the time of the reform, highlighting underlying political tensions.

Keywords: Property Taxes and Assessment, Housing Markets, Homeownership, Wealth Accumulation and Bequests

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1 Introduction

Taxation of wealth is proposed as a way to generate additional government revenue and potentially address the growing income and wealth inequality. Since housing constitutes a significant portion of total wealth, and its value relative to national income has been increasing over the past 70 years, property taxes have received growing attention in public debates in several countries (Borri and Reichlin, 2021, Bonnet et al., 2021). However, since housing is more evenly distributed than other forms of wealth and provides essential consumption services, property taxation has also become a source of political tension. For these reasons, some countries exempt owner-occupied houses from property taxes.

Another key issue in property taxation, besides whether owner-occupied housing should be taxed, is how to determine taxable values. In many countries, the property values used for taxation, known as cadastral values, do not reflect current market values (OECD, 2022). Furthermore, the gap between cadastral and market values is generally not uniform across property values. As a result, even if the statutory property taxes are proportional, the effective property taxes can be progressive or regressive, depending on whether the ratio of market to cadastral values is higher or lower for more expensive properties. Empirical evidence suggests that the effective property tax burden is often higher for lower-value properties, leading to a *de facto* regressive property taxation (McMillen and Singh, 2020).

How do owner-occupied exemptions and the progressivity of property taxes affect house prices, homeownership, and welfare? In this paper, I study revenue-neutral property tax reforms that remove the owner-occupied exemption and differ in their degree of progressivity. To do this, I develop a dynamic equilibrium model of housing. In the model, households go through a stochastic life cycle with uninsurable income risk, making decisions about consumption, savings, and housing. They can choose to be homeowners or renters, and the size of the house they live in. Both house prices and rents are determined in equilibrium. Households also have a bequest motive. Bequests are distributed to younger generations, with the probability of obtaining a bequest and its value depending on the household's current income. A construction firm supplies housing units using a technology with diminishing returns to scale. Finally, the government taxes household income and properties.

I calibrate the model to match key features of the Italian housing market, such as the homeownership rate and the discrepancy between market and cadastral values. The model also reproduces several non-targeted aspects of the Italian housing market, such as the life-cycle dynamics of homeownership and wealth, and the homeownership rate along the income and wealth distributions. Several factors make Italy an excellent case study to analyze property taxes and their progressivity. First, the owner-occupied houses are exempt from property taxes, although attempts to eliminate the exemption have been made by the government. Second, Italy has a high homeownership rate, at around 65%, and real estate constitutes a large share of household wealth (Liberati and Loberto, 2019). Third, bequests and inheritance play a significant role in the acquisition of housing, with approximately one third of households having inherited their owner-occupied house (Guiso and Jappelli, 2002). Finally, the Italian cadastral values significantly under-report the market value of properties, particularly for higher-value homes (Guerrieri, 2013, Curto et al., 2021, OECD, 2021). This implies that the assessment ratio, i.e., the share of market value captured by the cadastral value, is lower for more expensive properties and this increases the regressivity of the property tax system.

To incorporate the discrepancy between market and cadastral values of properties in the model, and the fact that more expensive properties have a lower assessment ratio, I estimate an effective property tax rate function. This function takes the market value of a property as input and provides the effective tax rate for that property as output. It does this by adjusting the statutory proportional property tax rate by the assessment ratio for properties of that market value. I estimate this function by constructing a municipal-level dataset, which contains information on market and cadastral values of properties in Italy. The estimated effective property tax rate decreases with market values. Hence, although the statutory tax rate is proportional, the effective tax rate is regressive: more expensive properties face a lower effective tax rate than cheaper ones.

The model is then used to conduct four revenue-neutral counterfactual scenarios. Revenue neutrality is achieved by adjusting labor income taxes to offset changes in property tax revenue. First, I remove the owner-occupied exemption. Homeowners pay property taxes on their primary residence using the regressive effective property tax rate. In the second counterfactual, I modify the regressive property tax rate to be proportional across all properties. I refer to this scenario as the flat tax reform. This policy can also be interpreted as adjusting the cadastral values to match market values.[1]

[1]These two counterfactuals reflect property tax system reforms previously attempted in Italy. See,

I find that, by entirely removing the owner-occupied exemption, property tax revenues collected from households as a percentage of GDP increase by 0.89 percentage points. However, this policy leads to a 2.6 percentage point drop in homeownership and a 2 percent decline in house prices. When removing owner-occupied exemption is complemented by adjusting cadastral values, i.e., implementing a flat tax on properties, the homeownership rate increases by 2.6 percentage points compared to the benchmark. This is driven by increased homeownership among households in the third and fourth wealth deciles. At the same time, property tax revenue as a percentage of GDP increases by 0.87 percentage points, almost the same amount as in the first counterfactual. Hence, the government can simultaneously boost property tax revenue and homeownership. The key mechanism behind these outcomes is a 4.4 percent decline in house prices compared to the benchmark. Furthermore, compared to the first counterfactual, the flat tax reform encourages households to purchase smaller houses, reducing the overall demand of housing units.

For the third and fourth counterfactuals, I analyze the effects of progressive property taxes. The progressive property tax rates reduce the tax burden on smaller houses and increase the one on larger houses. The third counterfactual is more progressive, exempting homes valued under 100,000 Euros, with rates rising gradually to 0.38% for median-valued homes, i.e., the same rate applied in the flat tax, and 1% for most expensive properties. The fourth is less progressive and taxes all homes, with rates starting at 0.2% for 100,000 Euros homes and increasing to 0.8% for the most expensive ones. Both systems reduce house prices by about 10% and boost homeownership, increasing by 11 percentage points under the more progressive plan and 8 points under the less progressive one. Wealth inequality also decreases, with the Gini coefficient dropping over 1 percentage point. Lastly, government revenue from property taxes rises significantly, by 0.71% of GDP for the more progressive system and 0.96% for the less progressive.

Finally, I estimate the welfare effects of the different reforms. In the long run, welfare, measured as the consumption change needed to keep individuals indifferent between steady states, improves in all scenarios. The overall welfare gain is 2.8% when all properties are taxed with a proportional property tax. When taxing properties with a progressive property tax, the welfare gain goes up to 4.4% for the more progressive, and 4.2% for the less progressive one. Despite higher property taxes, this increase in welfare is due to lower income taxes and the general equilibrium drop in house prices.

for example, Cencig (2012), Messina and Savegnago (2015), Agostini and Natali (2016).

Taking the transition from the benchmark to the new steady state into account, the average welfare of households alive at the time of the reform drops by 3%. However, this average number masks significant heterogeneity in welfare gains and losses across age groups. Around two thirds of households between the ages of 25 to 34 benefit from the reform, while less than 5 percent of households older than 55 years old benefit.

Literature. This work is closely linked to three strands of the literature: macroeconomic housing models, the distributional characteristics of property tax schedules, and the analysis of tax reforms in Italy. My model builds on several studies that have developed housing models with endogenous house prices to assess the effects of housing-related taxes, including those by Chambers et al. (2009), Kaas et al. (2020), and Li and Lin (2023).

An important finding in this literature is that reducing the preferential tax treatment of housing increases welfare. For instance, Gervais (2002) shows that welfare would improve if imputed rents were taxed or if mortgage interest payments were not deductible. Similarly, Sommer and Sullivan (2018) find that removing the mortgage payment deduction would lead to welfare gains and argue that homeownership rates would not decline.[2] Furthermore, Floetotto et al. (2016) show that while removing the asymmetric tax treatment of owner-occupied housing improves welfare across steady states for most agents, this benefit is not uniform during the transition, as some agents experience welfare losses. This latter point is also highlighted by Balke et al. (2025), who find that the optimal property tax for the US is higher than the current one in the long run, yet, when accounting for the transitional dynamics, increasing the tax rate might not be preferred.

My work contributes to this literature by focusing on the removal of the owner-occupied exemption and its interaction with the progressivity of the property tax rate. Hence, this paper is also related to the literature that examines the progressivity or regressivity of the property tax system.

This literature highlights three key aspects. First, housing is subject to numerous taxes and policies, making it challenging to characterize the system's distributional aspects (McMillen and Singh, 2020, Matsaganis and Flevotomou, 2007, OECD, 2022).

[2] Rotberg and Steinberg (2024) challenge these findings by showing that such welfare gains depend crucially on assuming a highly elastic rental housing supply. When the rental supply is less elastic—as suggested by empirical evidence—changes in homeownership policy or taxation can have substantial effects on equilibrium rents and, consequently, on renters' welfare.

Second, the overall distributional effects of the property tax system depend on the economy's homeownership structure (Bises and Scialà, 2014). Third, the progressivity of the property tax system depends on the accuracy of cadastral values. Cadastral values that systematically misreport some house values can alter the system, making it more or less progressive, or even regressive (Paglin and Fogarty, 1972, McMillen and Singh, 2020, Avenancio-León and Howard, 2022). A stylized fact in this literature is that the assessment ratio, i.e., the ratio of cadastral value to market value, tends to be higher for low-value properties. This implies that less valuable houses have cadastral values that capture a larger percentage of their actual market value, increasing the system's regressivity. This stylized fact holds also in the Italian context (Agnoletti et al., 2020).

In this paper, I account for the discrepancy of the cadastral and market value in the model by estimating the effective property tax function. By doing this, my work contributes to the literature by providing a quantitative analysis of the effects of updating cadastral values to reflect market values. Furthermore, this links the paper to the literature analyzing property tax reforms in Italy. For instance, Cammeraat and Crivelli (2020) use microsimulation to evaluate the redistributive effects of a tax revenue-neutral reform that shifts taxation from income to housing wealth and consumption in the Italian context, finding that it would create a more progressive tax system. Unlike a microsimulation, however, my model accounts for behavioral and second-round effects.

Furthermore, Liberati and Loberto (2019) and Oliviero and Scognamiglio (2019) evaluate the effects of the 2012 Italian property tax reform, which increased cadastral values and temporarily removed the owner-occupied exemption. The former employs a search and matching model, while the latter conducts an empirical causal analysis at the municipal level. Both studies, consistent with my findings, report that the reform led to a decrease in house prices. By using a quantitative model instead of an empirical analysis, I can demonstrate long-run effects and compute welfare changes. My modeling approach also allows for a more detailed household analysis and accounts for differences between market and cadastral values across the house price distribution.

In the next section, I describe the model. In Section 3 I calibrate it, showing how it matches Italian data. Section 4 presents the results from the policy experiments. Section 5 discusses the welfare implications. Section 6 concludes.

2 Model

I build a life-cycle model of homeownership in a small open economy with an exogenous safe interest rate r. It is populated by four types of agents: households, real-estate firms, a construction firm, and the government. Time is discrete and each period lasts one year. There is no population growth.

2.1 Households

Households live through a stochastic life cycle with five age groups $j = 1, ..., 5$. The first four periods represent the working ages and each age group should be considered as 10 years long, i.e., 25-34, 35-44, and so on. Households survive throughout the entire working age and move from one age group to the next with an aging probability given by $\vartheta_j = 1/10,\ j = 1, ..., 4$. The last age group covers the retirement period. Households within this age group exit the economy with a death probability of $\vartheta_5 = 1/20$. In order to maintain the mass of households in each group constant, newborns enter the first age group at a rate of $\vartheta_5/(1 + 40\vartheta_5)$.

Households in the first four age groups supply labor inelastically. The labor income is the sum of an age-dependent component, M_j, and a residual stochastic component, $\epsilon_{i,j}$:

$$\log y(j, i) = M_j + \epsilon_{i,j},$$

where the index i represents the residual income deciles, $i \in \{1, ..., 10\}$, so for each age group there are ten possible labor incomes. Movements across these ten labor incomes follow a Markov process with age-specific transition matrix Ψ_j. There are also ten levels of retirement income. The value of the retirement income corresponds to the average income level of the pre-retirement period income decile multiplied by a replacement rate and remains constant during retirement.

Households maximize expected lifetime utility and have preferences over consumption c and housing services s according to a non-separable period utility:

$$u(c, s; j) = \frac{1}{1-\sigma} \left[c^{\zeta} s^{1-\zeta} (1/n_j) \right]^{1-\sigma},$$

where σ is the degree of relative risk aversion and ζ is the expenditure share of consumption. Changes in household size throughout the life cycle are accounted for through n_j.[3]

Households can choose to buy a house that comes in discrete units $h \in \mathcal{H} = \{0, \underline{h}, ..., \bar{h}\}$, with $\underline{h}$ being the minimum housing size, and $\bar{h}$ the maximum.[4] Housing units have a per unit price of p. Thus, for a house of units h, the market value is ph. There exists a linear technology that transforms one unit of housing owned, h, to one unit of housing services, s. I assume that homeowners, $h > 0$, cannot purchase additional housing services on top of the ones provided by the house they own, this implies that $s \leq h$, if $h > 0$. Nonetheless, homeowners can rent out the part of their house that they do not consume, $h - s$, in the rental market at the rental rate ρ, becoming landlord households. Meanwhile, households that do not own a house, $h = 0$, obtain their housing services by renting a house in the rental market at the rental rate ρ. The minimum amount of housing services households can choose is smaller than the minimum size of housing units, $s \in \mathcal{S} = [\underline{s}, \bar{s}]$, with $\underline{s} < \underline{h}$ and $\bar{s} = \bar{h}$. This is done in order to account for the fact that rented houses tend to be of lower quality than owned houses, and that families can rent a part of a house.

Households incur transaction costs for buying and selling of houses that depend on the current market value, denoted $t^b ph$, and $t^s ph$ respectively. The transaction costs when buying include real-estate agents fees, legal fees, and real-estate transfer taxes, $\tilde{t}^b$.[5] Houses depreciate randomly, with an expected yearly depreciation rate of δ. A household that chooses next-period housing level $\tilde{h}'$ will start next period with housing level $h' = \tilde{h}'$ with probability $\pi_{dep}(h)$, and with housing level $h' = \tilde{h}'_{-1}$ with probability $(1 - \pi_{dep}(h))$, where $\tilde{h}_{-1}$ is the next smaller house in the grid $\mathcal{H}$. The probability $\pi_{dep}(h)$ are obtained such that the expected value of next period housing is equal to the expected depreciation rate $\tilde{h}'(1 - \delta)$.[6]

[3]The literature commonly uses the Cobb-Douglas form to aggregate consumption and housing services as there is a lack of strong evidence for the elasticity of substitution between durable and non-durable consumption being significantly different than unity (Fernandez-Villaverde and Krueger, 2011, Borri and Reichlin, 2021).

[4]The 0 in the housing set represents renting. More units represent a higher housing investment. One can think of these units to represent housing size, implying that more units means larger houses or house quality or location (Attanasio et al., 2012, Piazzesi and Schneider, 2016, Paz-Pardo, 2024). I discretize housing into 33 points. To better capture choices among smaller houses, the grid is constructed to be denser at lower values.

[5]Real-estate transfer taxes are levied on property transactions at the time of sale and collected by the government.

[6]This random depreciation is important in this model as houses come from a discrete set. Having a non-random depreciation would create houses outside of this set. The probability $\pi_{dep}(h)$ is different for each house size, and for the i^{th} house it is obtained as $\frac{h_i(1-\delta)-h_{i-1}}{h_i-h_{i-1}}$.

It is important to note that the use of the housing unit set $\mathcal{H}$ implies the indivisibility of housing. Hence, housing is different than capital, and households can become homeowners only if they have enough savings to purchase housing units $\underline{h}$ at the price $p\underline{h}$. In turn, this implies that policies that lower the price of house units p can increase homeownership by enabling poorer households to overcome this constraint.

Households can save by holding a safe asset a that pays a yearly interest rate r. The only way for a household to borrow is through a mortgage, which has an exogenous interest rate r^m and is subject to a down payment constraint given by:

$$a' > -(1-\theta_j)p\tilde{h}',$$

where a' is the next period asset choice, θ_j is the age-specific down payment requirement, and $\tilde{h}'$ is the next period housing choice before the random depreciation. Thus, $a < 0$ implies that the household has a mortgage.

Finally, retired households have a bequest motive that is given by:

$$\phi(B) = \frac{\phi_1(B+\phi_2)^{1-\sigma}}{1-\sigma}.$$

The bequest motive is characterized by two parameters (De Nardi, 2004, Kaplan et al., 2020). The first one, ϕ_1, reflects the importance of bequests motive. The second one, ϕ_2, captures the luxury nature of bequests. The bequest B includes both the financial and housing assets after transaction costs $B = a' + ph(1+t^s)$.

All bequests are collected and distributed randomly to the households in the first two age groups. For each of these households, the probability of obtaining the bequests and its value depend on their current income decile. For a household of age j and in income decile i, the probability of obtaining a bequest is given by $\pi_{beq}(j,i)$, while the value of the bequests obtained is given by $b'(j,i) = \bar{b} \times w_{beq}(j,i)$, with $\bar{b}$ being the base bequest and $w_{beq}(j,i)$ some weights that scale up or down the base bequest. As highlighted later on, the base bequest $\bar{b}$ is an equilibrium object.

2.2 Real-Estate Firms

The second set of agents that populate the economy are real-estate firms that rent out houses in the rental market at the rental rate ρ. Unlike household landlords, these firms have to pay a per-unit cost κ^m in order to rent out the house. This cost encompasses all costs that a renting agency incurs and a household landlord does not. These could be due to an information asymmetry between real-estate agencies and tenants, or any administrative and operational costs that real-estate agencies face and household landlords do not.[7]

The value of a real estate firm is given by:

$$V_r = (\rho - \kappa^m + (1-\delta)V_r)/(1+r),$$

and combining this with the zero profit condition $V_r = p$, we obtain a relationship between the house unit price p and the rental unit price ρ:

$$\rho = p(r+\delta) + \kappa^m. \tag{1}$$

Importantly, higher monitoring cost leads to a higher rental rate and a lower price-to-rent ratio, encouraging households to purchase their own home.[8]

2.3 Construction Firm

A representative construction firm builds housing units I. These homogeneous units are combined to form the houses of different sizes in $\mathcal{H}$.[9] The firm operates with an increasing and convex cost function $K(I)$, which captures land-use restrictions and scarcity

[7] As described by Kaas et al. (2020), information asymmetry costs may arise as the real-estate firms need to monitor tenants in houses that are far away, while household landlords might live in proximity to the tenants. Instead, administrative and operational costs may arise as the real-estate firms need to oversee several tenants and pay wages to agents, while the household landlord does not as they usually only have one property to rent out.

[8] In this framework, rental supply is perfectly elastic, contrary to empirical evidence that it is relatively inelastic (Rotberg and Steinberg, 2024). From Equation (1), changes in house prices pass through to rents, but the fixed monitoring cost κ^m dampens the proportional response.

[9] This assumption implies that all housing units are produced with the same technology and can be flexibly allocated across the housing grid.

of building materials.[10] Profit maximization leads to the following relationship between new housing construction and the unit price of housing:

$$p = K'(I). \tag{2}$$

Since there is no population growth, the housing stock must be constant in steady state. This implies that new construction must exactly replace depreciation, $I = \delta \bar{H}$.

2.4 Government

The government collects taxes only from households. These include taxes on income, property, and real-estate transfers to finance government spending. In line with Italian law, households can deduct from their taxable income a portion ω of the interest payment for a mortgage. As a result, taxable income, $\tilde{y}$, can be less than labor income, y. Income taxes are computed using the tax function $T(\tilde{y})$, with $\tilde{y} \times T(\tilde{y})$ representing total income tax liability.

The property tax function in the model is $\mathcal{T}(pv)$, where v represents the house units being taxed, and pv is the market value of the units being taxed. To capture the regressivity introduced by the mismatch between market and cadastral values, $\mathcal{T}(pv)$ should be a downward-sloping function. In the benchmark economy, the house units taxes are given by $v = h - s$ and hence $p \times (h - s) \times \mathcal{T}(p(h - s))$ determines the total amount of property taxes due by an household. Finally, the government collects the real-estate transfer tax, $\tilde{t}^b$. For every house purchased by households, i.e. $\tilde{h}' \neq h$, the government collects $\tilde{t}^b \times p\tilde{h}'$.

2.5 Household Problem

Any household begins each period with the state vector (j, i, a, h), where j is the age group, i is the income decile, a is the safe asset stock, and h is the current housing stock. The state variables j and i change from one period to the other according to the aging probabilities ϑ_j and the transition matrix Ψ_j respectively. In each period the household

[10] See Davis and Heathcote (2005) for a full specification of a construction technology with land and structures.

has to choose the amount of consumption c and housing services s, and the amount of assets a' and gross housing stock (before depreciation) $\tilde{h}'$ with which they will start the next period. Households in the first four age group solve the following problem:

$$V(j,i,a,h) = \max_{c,s,a',\tilde{h}'} u(c,s;j,h) + \beta\,\mathbb{E}_{j,i}[V(j',i',a'+b',h')] \tag{3}$$

subject to:

$$\begin{aligned} c + a' + p\tilde{h}' = {} & y(j,i) + [1 + r\mathbb{1}_{a>0} + r^m\mathbb{1}_{a<0}]a + ph + \max\{\rho(h-s),0\} \\ & - \rho s\mathbb{1}_{h=0} - \tilde{y}T_j(\tilde{y}) - \mathbb{1}_{\tilde{h}'\neq h}[t^b p\tilde{h}' + t^s ph] - p\max\{(h-s),0\}\mathcal{T}(p(h-s)), \end{aligned} \tag{4}$$

$$\tilde{h}' \in \mathcal{H};\ \ s \geq 0;\ \ s \leq h \text{ if } h > 0, \tag{5}$$

$$a' \geq -p\tilde{h}'(1-\theta_j), \tag{6}$$

$$h' = \tilde{h}' \text{ with prob. } \pi_{dep}(h) \text{ or } \tilde{h}'_{-1} \text{ with prob. } 1-\pi_{dep}(h), \tag{7}$$

$$\begin{aligned} \tilde{y} = {} & y(j,i) + r\max\{a,0\} + \rho\max\{0,(h-s)\} \\ & - \omega r^m \min\{\max\{-a,0\}, p(1-\theta_j)\min\{h,s\}\}, \end{aligned} \tag{8}$$

and

$$b' = \bar{b}w_{beq}(j,i) \text{ with prob. } \pi_{beq}(j,i).\ \ \pi_{beq}(j,i) = 0 \text{ if } j \in \{3,4\}. \tag{9}$$

Regarding the constraints, Equation (4) is the budget constraint. The right hand side includes seven components: a) the labor income, b) the capital gains from the safe asset if this is positive, or the mortgage cost if the asset is negative, c) the value of the current house, d) the rental income, or the rental cost if no house is owned, e) the income taxes that are due, f) the transaction costs in the case that the household changes house size, g) and finally the taxes on rented out property. Equation (5) represents the housing constraint, showing that houses can belong only to a definite set, and homeowners cannot obtain more housing service than the one provided by their owned houses. Equation (6) shows the borrowing constraint faced by households and how the only tool for borrowing is a mortgage. Equation (7) shows how the housing decision $\tilde{h}'$ for the next period turns into the actual housing stock for next period. Equation (8) shows the taxable income, composed of the labor income, capital and rental income and the deductions for the owner-occupied share of the house. Finally, Equation (9) presents the probability for households in the first two age groups to obtain a bequest b', with the value of the bequest determined by the income decile.

Meanwhile, households in the last age group, J, solve a similar problem, with the constraints given by Equations (4) to (8) and the value function $V(J,i,a,h)$ being:

$$V(J,i,a,h) = \max_{c,s,a',\tilde{h}'} u(c,s;J,h) + \beta\left[(1-\vartheta_5)V(J,i,a',h') + \vartheta_5\phi(a'+p(1-t^s)h')\right] \quad (10)$$

with

$$\phi(B) = \frac{\phi_1(B+\phi_2)^{1-\sigma}}{1-\sigma}. \quad (11)$$

The value function for the last age group accounts for the bequest motive and the fact that retirees do not move across income deciles.

Housing choice. To better understand the decision between owning and renting, it is useful to summarize the effective cost of occupying a house in this framework. For homeowners, assuming no outstanding mortgage and no change in housing size across periods, the user cost of owning has three components: the opportunity cost of capital tied up in the property, depreciation, and property taxes. In the steady state, i.e., without expected capital gains on house prices, the user cost of owning a house of size h is therefore:

$$uc^{own} = ph(r+\delta) + pv\mathcal{T}(pv), \quad (12)$$

where v denotes the house units being taxed, equal to $h-s$ in the benchmark economy.

For renters, the user cost is simply the rent paid, ρs. In equilibrium, using the zero-profit condition of real estate firms, this can be written as

$$uc^{rent} = ps(r+\delta) + s\kappa^m. \quad (13)$$

Hence, renting embeds the same opportunity cost and depreciation as owning, but rather than the property tax, it includes the monitoring cost κ^m. For low property taxes, renting is therefore relatively more expensive, which provides households with an incentive to own if they can overcome the down-payment constraint.

2.6 Equilibrium

The stationary equilibrium is the collection of the household value function $V()$, the household policy functions for consumption, housing services, financial assets and housing asset $C(), S(), A(), H()$, probability measure μ over the state variables (j, i, a, h), bequest distribution $B()$, house and rental unitary prices p, ρ, and housing stock $\bar{H}$ such that:

1. Households value functions and policy functions solve the household problem.
2. Real-estate firms maximize their profits, creating the relationship between house prices and rents (Equation 1).
3. Construction firms maximize their profits, creating the relationship between house prices and new housing construction (Equation 2).
4. Housing market equilibrium holds, which means that all housing units are occupied by either owners or renters: $\bar{H} = \int S(j, i, a, h) d\mu(j, i, a, h)$.
5. μ is a stationary distribution, invariant to stochastic processes (j, i).
6. The total bequest collected from the elderly is equal to the total bequests distributed to the younger generations: $\bar{B} = \vartheta_J \int a' + p(1 - t^s)h' d\mu(J, i, a, h) = \int \pi_{beq}(j, i)\bar{b}w_{beq}(j, i) d\mu(j, i, a, h)$.
7. The government budget balances, hence the government spending is equal to the tax raised through income, property taxes, and real-estate transfer:

$$G = \int \left[T(\tilde{y}(j, i)) + \mathcal{T}(pv(j, i, a, h)) + \tilde{t}^b pH(j, i, a, h)\mathbb{1}_{H(j,i,a,h)\neq h}\right] d\mu(j, i, a, h),$$

   where term is income taxes, the second is property taxes on taxed units $v()$, that is obtained from the house and housing services choices, and the last term is the real-estate transfer tax, that is multiplied by house value of transacted houses.

3 Calibration

The model is calibrated to the 2016 Italian economy. Parameters are set either by using external sources or calibrated internally by matching moments generated by the model with moments retrieved from the data. Table 1 and Table 2 summarize the values of the externally set and internally calibrated parameters, respectively. The data sources are the Italian Survey on Household Income and Wealth (SHIW), the European Union Statistics on Income and Living Conditions (EU-SILC), and data from the Italian Tax Agency. Appendix A provides information on the data sources used. Prices are in 2016 Thousands of Euros.

3.1 Externally Calibrated Parameters

Households. As indicated above, we set the aging probability for the first four age groups as $\vartheta_j = 1/10$ while the death probability as $\vartheta_5 = 1/20$ to obtain the desired period representation.[11] The period preferences of households are characterized by 3 parameters, the risk aversion, the expenditure share of consumption, and the household size. These are calibrated externally. The first takes the standard value found in the literature, $\sigma = 2$. The expenditure share of consumption is computed from the SHIW data by comparing the share of expenditure on consumption and on rent among renters obtaining $\zeta = 0.775$ (Davis and Ortalo-Magné, 2011). I obtain the age-group specific household size, n_j, from the EU-SILC dataset.[12]

Houses. The minimum and maximum housing unit, which characterize the housing set $\mathcal{H}$, are set to match approximately the 10th and 90th percentile of housing value calculated using the SHIW, obtaining $\underline{h} = 60.000, \bar{h} = 500.000$. Transaction costs for selling and buying are, respectively, $t^s = 3\%$ and $t^b = 9\%$ of the house market value. The buying transaction costs include also the real-estate transfer tax $\tilde{t}^b = 3\%$. These numbers are set to match the transaction cost estimates for Italy presented in the Online Appendix of Kaas et al. (2020). Finally, house depreciation is set to give houses 100

[11] These probabilities imply that, in the stationary population, each working-age group represents one sixth of the total population, while retirees represent two sixths. Although this does not match the actual Italian demographic distribution, it ensures a stationary population—having unequal age-group sizes would otherwise require modeling demographic growth or decline.

[12] Each n_j is set to match the mean of the adjusted household size of the age group found in the data. Household sizes are adjusted using the OECD equivalence scale (or Oxford scale).

year lifespan, $\delta = 0.01$ as in Kaas et al. (2020).

Assets. The safe interest rate is set to match the average from 1995 to 2016 of the real yield of 10-year Italian bonds, $r = 0.03$. Meanwhile, the mortgage interest rate is obtained from the average between 1995 and 2010 of real mortgage interest from the Bank of Italy data, $r^m = 0.04$.[13] The mortgage down payment for the first three age groups is $\theta_j = 0.4$ for $j \in \{1, 2, 3\}$, as reported by Chiuri and Jappelli (2003). For the latter two age groups, to avoid rapid mortgage adjustments, a higher value for the down payment constraint is set. Following Kaas et al. (2020), I set $\theta_4 = 0.6$ and $\theta_5 = 1$.

Bequests. Bequests are collected from retirees who exit the model and distributed to the first two age groups. Both the probability of receiving a bequest and the value received are calibrated using the 2002 wave of the SHIW, the only wave that contains complete information on all types of transfers. Because the transfer module sample is small, I divide households into three broad income groups: low (first to third deciles), medium (fourth to seventh), and high (eighth to tenth).

The probability of obtaining a bequest in any given period is denoted $\pi_{beq}(j, i)$. Only the first two age groups are eligible, so $\pi_{beq}(j, i) = 0$ for $j \in \{3, 4, 5\}$. Furthermore, I assume that $\pi_{beq}(1, i) = \pi_{beq}(2, i)$.[14] To estimate $\pi_{beq}(j, i)$ across income groups, I compute the fraction of households aged 25–44 that received a transfer in each group (Figure B1a in Appendix B). Finally, I rescale these fractions so that the average probability across groups is 0.05, consistent with the demographic structure of the model: for each retiree who dies, there are about 20 households in the first two age groups.

To capture heterogeneity in bequest size, a base bequest $\bar{b}$ is multiplied by weights $w_{beq}(j, i)$ that vary by age and income. I set $w_{beq}(1, i) = w_{beq}(2, i)$ for all i. I estimate the weights by comparing the average transfer value received by households aged 25–44 across the three income groups (Figure B1b in Appendix B). The weight for the lowest group is normalized to one, and the others are expressed relative to it. The base bequest $\bar{b}$ is an equilibrium object chosen so that the total value of bequests left by retirees equals the total value received by younger households. Table 1 reports the resulting $\pi_{beq}(j, i)$ and $w_{beq}(j, i)$. Both the probability of receiving a bequest and the relative size

[13] https://www.bancaditalia.it/statistiche/basi-dati/bds/index.html

[14] In the SHIW, the fraction of households receiving a bequest or *inter-vivos* transfer is similar across all four working-age groups. In the model, however, I restrict bequests to the first two groups to avoid introducing an additional state variable that tracks whether a bequest has already been received.

of transfers are roughly twice as large for households in the top income group as for those in the bottom group.

Labor income process. The labor income is estimated using data from EU-SILC from 2007 to 2012. For each of the first four age groups, three parts need to be estimated: the age specific component M_j, the age specific residual income decile $\epsilon_{i,j}$, and the age specific transition matrix Ψ_j. The first two are obtained by regressing for each age group separately the log household gross labor income on a constant, year dummies, and age and age squared of the head of the household. The coefficients of this regression, together with the average values of the independent variables, are used to obtain M_j. To obtain the residual income decile, for each age group the regression residuals are calculated and divided into decile bins $I = \{1, ..., 10\}$. $\epsilon_{i,j}$ is the mean of the regression residual within decile i and age group j. The transition matrix for each age group is estimated from the fraction of households within the age group that move from one income decile i in one year to i' in the following year.

For the retirees, each pension decile is estimated by multiplying the gross replacement rate with the average income in that decile across all four working age groups. The gross replacement rate in Italy is 0.645 (OECD, 2011). Retirees do not change pension decile throughout their retirement, hence the transition matrix Ψ_5 is the identity matrix.

Taxes on income. The share of the mortgage interest that can be deducted from taxable total income $\tilde{y}$ is set to $\omega = 19\%$ in line with the Italian tax law. Taxes on taxable total income are calculated using the tax rate function $T(\tilde{y}) = 1 - \lambda_0 \tilde{y}^{-\lambda_1}$, with total taxes due being $\tilde{y}T(\tilde{y}) = \tilde{y} - \lambda_0 \tilde{y}^{1-\lambda_1}$. This two parameter functional form has been used extensively in the literature as it can be easily estimated and it identifies separately a tax level parameter, λ_0, and a tax progressivity parameters, λ_1, offering the possibility of altering one without affecting the other (Benabou, 2002, Heathcote et al., 2017). Higher level of λ_1 lead to higher level of progressivity. I estimated the parameters using EU-SILC data for the years between 2007 and 2016. I regressed the log of the net household total income on a constant and the log of gross total income.[15] Figure B2 in Appendix B shows the estimated average tax rate across gross income levels. The corresponding tax function is:

$$T(\tilde{y}) = 1 - 1.474\tilde{y}^{-0.064}.$$

[15]Mortgages deductions should be excluded, however the EU-SILC does not allow for this.

Taxes on property. In the model property taxes are paid on market value, and not on cadastral values. Thus, in order to account for the observed discrepancy between the two, I construct the effective property tax rate function. The aim of this function is to correct the statutory property tax rate, $\tau_p = 0.76\%$, for the assessment ratio, i.e., the percentage of market value captured by the taxable value. As a clarifying example, let CV_i be the cadastral value of a taxed house i, and MV_i the market value. Then, the effective property tax rate for this house is given by:

$$\mathcal{T}_i = \tau_p \times \frac{CV_i}{MV_i}, \tag{14}$$

where the first part is the statutory property tax rate and the second part is the assessment ratio. More generally, let v be the house units being taxed and pv their market value. The effective property tax rate function $\mathcal{T}(pv)$, takes as input the market value of taxed units, and provides as output the tax rate to apply for a property with this market value.

To estimate $\mathcal{T}(pv)$, I combine three different sources of data for 2016, all obtained from the Italian Tax Agency, and construct a municipal level dataset of market and cadastral values.[16] Then, using this data, I run a municipal-level regression, where the dependent variable is the cadastral value, and the independent variable is the market values and a constant. The estimates, that can be found in Table B1 in Appendix B, enable me to obtain an estimated cadastral value for a given market value. Finally, I plug the estimated cadastral value in the effective property tax rate function, obtaining:

$$\mathcal{T}(pv) = \tau_p \times \frac{0.172pv + 59.51}{pv},$$

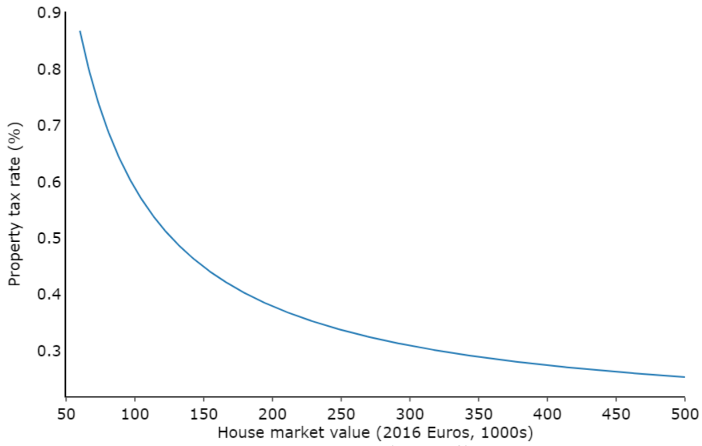
where the first term is the national property tax rate, the fraction is the estimated assessment ratio, and v is the house units that are taxed.

Figure 1 shows $\mathcal{T}(pv)$ function for different market values. The function is downward sloping, hence it is able to capture the empirical evidence that more expensive houses tend to have a relatively lower cadastral values. Additionally, it is possible to see that houses with a very low market value have an effective tax rate which is above the national

[16]The Appendix A provides information on the data construction. Notice that the Italian Tax Agency has both information on cadastral values and estimates of the market value of properties. However, these market value estimates are not used to update the cadastral value, as these are determined using criterias established in the late 1980s.

property tax rate. This is inline with the Figure B3 in Appendix B, that shows that in some municipalities the average market value is below the average cadastral value. Finally, note that in the benchmark economy, because of the owner-occupied exemption, only rented out units are taxed and hence $v = h - s$.

Figure 1: Calibrated Effective Property Tax Function $\mathcal{T}()$



Notes: *The figure shows the property tax rate for different market values of properties obtained with the calibrated property tax function.*

Construction firm. Following the literature (Kaas et al., 2020), the construction cost function is specified as $K(I) = k_0 I^{1+\psi}/(1+\psi)$. Profit maximization implies the relationship between the unit price of housing and new construction, $p = k_0 I^{\psi}$. This relationship depends on two parameters: the construction cost level k_0 and the inverse of the housing supply elasticity ψ. To calibrate ψ, I use the inverse of the long-run price elasticity of new housing supply.[17] Based on the estimate for Italy by Caldera and Johansson (2013), the elasticity is 0.258, implying $\psi = 3.88$. This is a relatively low elasticity, meaning that housing investment responds little to price changes and that the cost function rises steeply.[18] The construction cost level is calibrated internally.

[17]This elasticity measures how many additional houses are built for a given increase in house prices. The "long-run" refers to an equilibrium in which the housing stock adjusts fully, which fits with the steady-state analysis here.

[18]Inchauste et al. (2018) estimate a much higher long-run elasticity for Italy, 1.8, which corresponds to $\psi = 0.56$. I have also run the model with this parameter. While the numerical results differ, the overall conclusions remain robust.

Table 1: Externally Calibrated Parameters

	Parameters	Values
Aging probabilities	ϑ_1,ϑ_2,ϑ_3, ϑ_4	0.1
Death probability	ϑ_5	0.05
Equivalized HH size	n_1, n_2, n_3, n_4, n_5	1.55,1.79,1.96,1.79,1.44
Risk aversion	σ	2
Expenditure share of consumption	ζ	0.775
Interest rates	r, r^m	0.03, 0.04
Down payment	θ_1,θ_2,θ_3 θ_4, θ_5	0.4,0.4,0.4,0.6,1
Transaction costs	t^s,t^b,$\tilde{t}^b$	3%, 9%, 3%
Depreciation rate	δ	0.01
Housing size (Thousands of Euros)	$\underline{h}$, $\bar{h}$	60, 500
Construction elasticity	ψ	3.88
Deductible mortgage interest share	ω	19%
Income taxes	λ_0, λ_1	1.474,0.064
National property tax rate	τ_p	0.76%
Transfer probability	$\pi_{beq}(j,i)$	3.42%, 5.01%, 6.57%
Transfer weights	$w_{beq}(j,i)$	1, 1.52, 2.08

Notes: *The table shows the parameters calibrated using external sources such as other papers or own calculations using SHIW, EU-SILC or Bank of Italy data. All information can be found in the text and in the appendixes.*

3.2 Internally Calibrated Parameters

The remaining 5 parameters are calibrated internally by minimizing the distance between moments of interest generated by the model and retrieved from the data. The first parameter is the discount factor β, which identifies the patience of household and hence is calibrated to target the average wealth of households. The second parameter is the cost of real-estate firms κ^m, which defines the relationship between the house unit price and the rental price. As discussed above, a higher cost increases the rent rate and lowers the price-to-rent ratio, making housing investment more convenient for households. Therefore, this parameter is identified by the average homeownership rate.[19]

The third and fourth parameters relate to the bequest motive function $\phi(B)$. The two parameters are directly linked to the wealth level and wealth distribution of the last

[19] In the model households that own a property cannot rent additional space. In order to match this with the data, the statistics I report on homeownership are on household that live in the house they own, and not on households who own some properties. Notice however that in the case of Italy the difference is minor, around 2 p.p.

age group. The importance of the bequest motive parameter, ϕ_1, affects the willingness of retirees to save as they obtain a utility from dying with positive assets. Hence, this parameter is set to match the average wealth of households in the last age group. The luxury of bequests parameter, ϕ_2, determines the bequests left across the retirees' wealth distribution. The parameter affects mainly the lower end of the wealth distribution, relating it to wealth inequality within this age group. Hence, I target the percentile ratio P50-P25. This shows the ratio of the net wealth belonging to household at the 50th percentile over the household at the 25th percentile. Finally, the last parameter is the scale term of the cost function of the construction firm k_0, which is set to normalize the unit price of houses $p = 1$ in the benchmark economy.

Table 2 presents the selected values for the parameters, and the targeted moments in the model and in the SHIW data. Note that the relative size of the age groups differs between the model and the data. In order to account for this, totals or averages in the data are given by a weighted average of the age group mean. The weights are given by the relative size of age groups in the model. The model matches the targets very well.

Table 2: Internally Calibrated Parameters

Target	Parameters	Value	Data
Average wealth	$\beta = 0.9545$	194.4	192.3
Homeownership rate	$\kappa^m = 0.01495$	65.0	65.2
Average wealth of retirees	$\phi_1 = 1145.0$	238.4	238.1
Wealth distribution of retirees, P50-P25	$\phi_2 = 610.0$	2.6	2.8
Price normalization	$k_0 = 0.239$		

Notes: *The table shows the internally calibrated parameters and compares the target outcomes estimated from the model and from the SHIW 2016 data.*

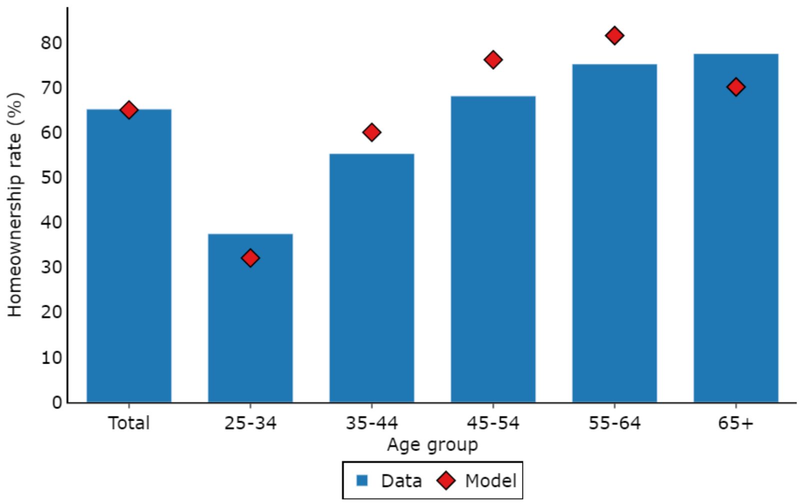
3.3 Untargeted Moments

Next, I report several untargeted moments. I focus on homeownership by age, income and wealth deciles; total and housing wealth by age; and percentage of homeowners with an outstanding mortgage by age.

Figure 2 shows the homeownership rate by age in the data and in the model. Overall the model is able to replicate very well the levels and the life cycle trends. A key feature of the model that ensure the good fit is the bequest motives of the last age group. This ensures that retirees do not dis-save all their wealth and a large amount of bequest is transferred to younger generations.

Figure 3 shows the homeownership rate by deciles of wealth and income. Also in this case, the model does a good job in replicating the data. Even though ownership is underestimated for the 3rd and 4th wealth decile, the model replicates the extreme jump present in homeownership rate across wealth deciles. Furthermore, as in the data, the distribution of homeownership is flatter across income deciles than wealth deciles.

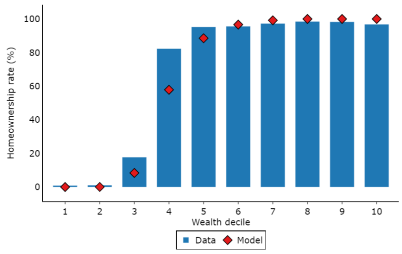
Figure 2: Homeownership Rate by Age



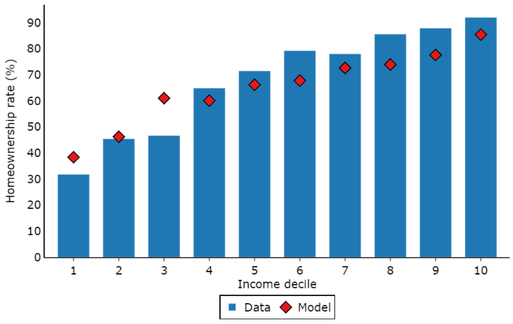
Notes: *The figure compares the homeownership rate by age estimated from the calibrated model and from the SHIW 2016 data. The bars represent the actual data, while the diamonds represent the model's estimates.*

Figure 4 compares the total wealth and housing wealth in the data and the model by age group. Focusing on total wealth, the bars on the left, both the life cycle pattern and the levels are matched very well. Instead, regarding the housing wealth, the darker green bars on the right, the model replicates the life cycle pattern, but underestimates the level. One reason for this is that in the data, housing wealth is defined as the value of any real estate. Yet, in the model, the real estate wealth of homeowners is only the house they own and the part of that house that they rent out. Thus, the data is capturing a broader concept of real estate wealth that the model ignores. By comparing the model's results to data on only the value of the main property (the lighter green on the right side), the model actually matches also the levels very well.

Figure 3: Homeownership Rate by Deciles



(a) Wealth deciles



(b) Income deciles

Notes: *The two figures compare the homeownership rate by wealth and income decile, respectively, estimated from the calibrated model and from the SHIW 2016 data. The bars represent the actual data, while the diamonds represent the model's estimates.*

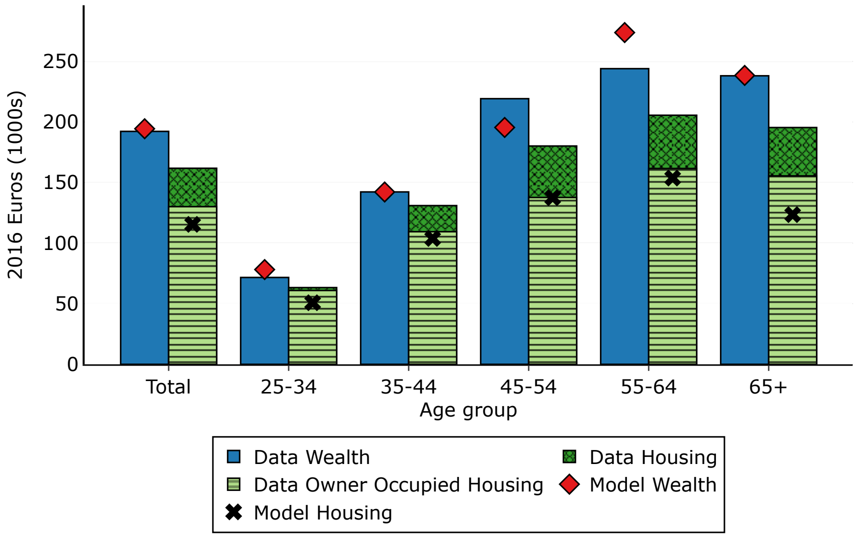
Finally, Figure 5 shows the percentage of homeowners with an outstanding mortgage in the data and the model. The model manages to replicate the life cycle trend and the overall percentage of homeowners with an outstanding mortgage. However, the use of mortgages by homeowners in the first four cohorts is overestimated, while homeowners in the last age group do not hold any mortgage.[20] This suggests that the model is not able to capture some existing financial constraints.[21]

Regarding taxes, in the benchmark economy property taxes are only collected from household landlords on the share of their housing asset that they rent out. The model predicts property tax revenues from households to be 0.03% of GDP. This percentage is an order of magnitude lower than the 1% of GDP collected in Italy currently from property taxes (Figure B4). Yet, there are three aspects worth noting. Firstly, the revenues in the data above include dwellings used as residences and dwellings used for productive or other purposes, whereas the model focuses only on dwellings used for residences. Secondly, in the model only households pay property taxes, while in reality firms and governmental agencies also pay property taxes. Lastly, in the model

[20]Despite the overestimation of mortgage usage in the younger cohorts, the correct average is achieved because the oldest age group, with close to 0% mortgage holders among homeowners, is twice as large as each of the younger age groups and thus carries more weight in the calculation of the average. Furthermore, the homeownership rate in this older group is particularly high, which helps balance out the overestimation in the younger cohorts.

[21]Examples of such constraints include income and employment stability requirements, fixed payment schedules, and refinancing or administrative costs.

Figure 4: Total and Housing Wealth by Age

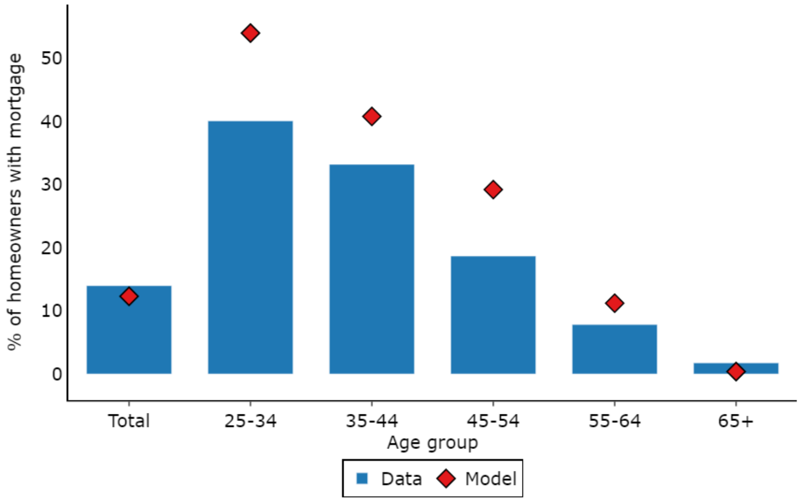


Notes: *The figure compares the total wealth and real estate wealth by age estimated from the calibrated model and from the SHIW 2016 data. Left bars and diamonds: total wealth (data vs. model). Right bars and markers: housing wealth. Light bar: main residence only; dark bar: all real estate.*

a household can choose only between occupying the entirety of their housing asset, or leasing a part and occupying the rest. Hence, the model does not allow for secondary houses that are not leased but are subject to property taxes.

While data on amount of revenue taxes by different type and use of dwelling, and kind of legal entity cannot be easily found, some estimates to understand the magnitude of the three problems mentioned above can be obtained. By starting from data on cadastral rents by type and use of dwelling for different kinds of legal entity (Table B2), I obtain that property tax revenue is approximately 0.12% of the 2016 GDP. The model still underestimates the property tax revenues as % of GDP, yet the estimates are comparable in magnitude. Furthermore, I obtain that the removal of the owner-occupied exemption, without accounting for general equilibrium effects, should increase the tax revenue by approximately 14 Billion Euros.

Figure 5: Mortgage Uptake by Age



Notes: *The figure compares the mortgage uptake estimated from the calibrated model and from the SHIW 2016 data. The bars represent the actual data, while the diamonds represent the model's estimates.*

4 Counterfactuals

I use the quantitative laboratory to evaluate several potential reforms. I perform four policy experiments. First, I remove the owner-occupied exemption, i.e., households are taxed on all housing units h they own, but the effective tax rate follows the regressive schedule of the benchmark economy. The second counterfactual adds to this the adjustment of the cadastral values so that they reflect the market values. This implies that the regressive property tax schedule is replaced by a flat property tax. The flat property tax rate applies to all housing units h owned by the household and is set to 0.38%. This value is obtained by dividing the the statutory national property tax rate (0.76%) by the average market to cadastral value ratio (2) (Cammeraat and Crivelli, 2020). Since the first two counterfactuals correspond to past reforms and ongoing political discussions in Italy, I refer to them as the main reforms.

For the third and fourth policy experiments, I analyze the effects of removing the owner-occupied exemption under progressive property tax schedules. The third counterfactual uses a more progressive schedule, while the fourth a less progressive one. The Appendix C shows the effects of a fifth counterfactual, where I remove the owner-occupied exemption and apply a proportional property tax on the house value net of mortgage. This counterfactual is not discussed in the main text, as results are similar to the ones obtained with the Flat Tax reform.

For each counterfactual I present the results with tax revenue neutrality. Tax revenue neutrality is achieved by changing the level of taxation λ_0 ensuring that the absolute tax revenue remains the same, i.e., the increase in tax revenues from property is given back to the household by lowering taxes on income.

4.1 Main Reforms

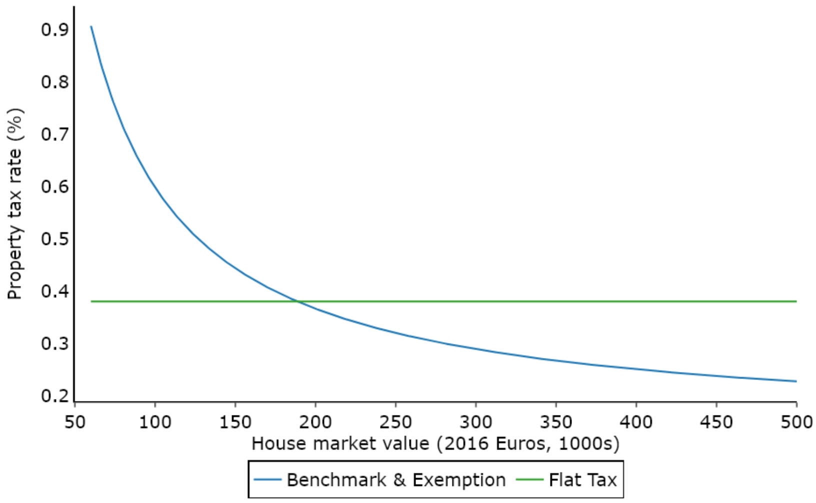
The effective property tax rate applied in these counterfactuals can be seen in Figure 6. Effective property taxes are regressive in the benchmark and the first counterfactual, denoted as Exemption, but flat for the second counterfactuals, denoted as Flat Tax. Due to the presence of the owner-occupied exemption in the benchmark, the regressivity of the property tax rate does not play a significant role. Meanwhile, in the first counterfactual, where the exemption is removed, the regressive tax rate increases the property taxes, but relatively less for larger properties. Finally, when moving to the counterfactuals with a flat tax, properties with a low market value (less than 200 Thousand Euros) face a lower effective property tax rate, while houses with a larger market value face a higher one, compared to the first counterfactual.

Table 3 compares the several outcomes of interest between the benchmark and the two counterfactuals. Comparing the benchmark to the first counterfactual, column titled Exemption, we observe that the tax revenues from property increase by 0.89 percentage points, approximately 14 Billion Euros.[22] However, as expected, the house price and the homeownership rate drop, by 2 percent and 2.6 percentage points, respectively. The removal of the owner-occupied exemption increases the user cost of owning a house, as defined in equation (12), reducing the incentives to own and homeownership. Furthermore, the regressive property taxation schedule that applies makes the user cost increase relatively more for properties with lower market values.

The result for the second experiment can be seen in the fourth column of Table 3, Flat Tax. Whereas property tax revenue as % of GDP is comparable to the first counter-

[22] An interesting aspect worth remarking is that the model predicts an increase in property tax revenue similar to the one obtained through the back-end calculations from cadastral rents discussed in the previous section.

Figure 6: Effective Property Tax Rate in Counterfactuals



Notes: *The figure compares the effective property tax rate in the benchmark and first two counterfactuals.*

factual (reaching 0.9%), homeownership rate actually increases by 2.6 percentage points compared to the benchmark. Nonetheless, these results are accompanied by a larger decrease in the house unit prices, which drop by 4.4 percent. This counterfactual shows that if the owner-occupied exemption is accompanied by the adjustment of the tax base to market values, i.e., a flat property tax rate, homeownership rate can actually increase. What are the mechanisms for different effects on homeownership in the experiments? The main reasons for this results, which will be analyzed below, are the changes in house prices and the changes in effective property tax rates. The lower house price enables households in lower wealth deciles to increase their homeownership. Meanwhile, the flat property tax rate encourages households to live in smaller houses, reducing the demand for house units.

Figure 7 shows the homeownership rate by wealth and decile across the two counterfactuals. Regarding wealth, Figure 7a, homeownership rate for the top 4 deciles is approximately unchanged across the experiments. With only the owner-occupied exemption, the homeownership rate among households between the third and fifth wealth decile declines, as the higher property taxes made housing investment less attractive, especially for cheaper houses. Instead, by comparing the first to the second counterfactual, we can observe that as house prices decrease poorer households between the third

Table 3: Main Property Taxation Reforms

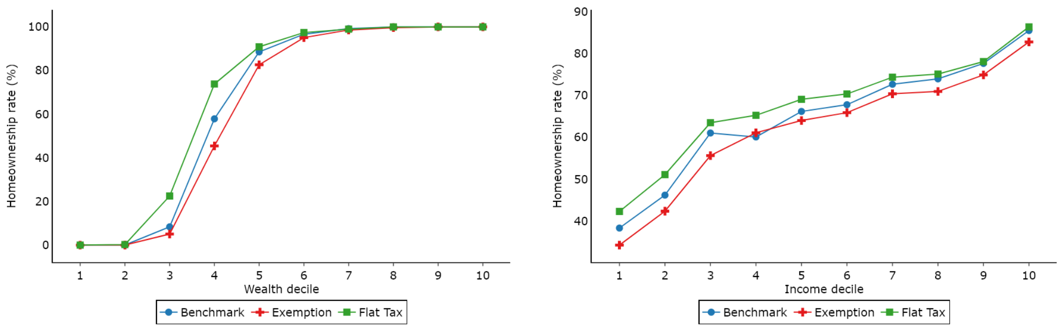
	Bench	Exemption	Flat Tax
Price	1.0	0.98	0.956
Homeownership Rate	65.0	62.4	67.6
Wealth	194.4	193.3	195.7
Real Estate Wealth	115.5	111.9	112.0
% of Owner with Mortgage	12.3	11.4	11.8
Tax Revenue as % of GDP	0.03	0.92	0.9
Gini (Wealth)	0.486	0.49	0.483

Notes: *The table compares the main outcomes of interest across the benchmark and the first two counterfactuals. The counterfactual are tax revenue neutral, obtained by changing the level of the income taxes. Counterfactual 1 (Exemption) is the removal of the owner-occupied house exemption. Counterfactual 2 (Flat Tax) is the removal of the owner-occupied house exemption and the adjustment of the cadastral value to match the market value.*

and fifth wealth decile can afford to become homeowners.

Regarding homeownership along the income distribution, Figure 7b, and across age groups, Figure 8, the changes in homeownership are spread more equally across these distributions. In the first counterfactuals, homeownership drops for households in all income deciles and age groups, while for the second it increases.

Figure 7: Homeownership Rate by Deciles

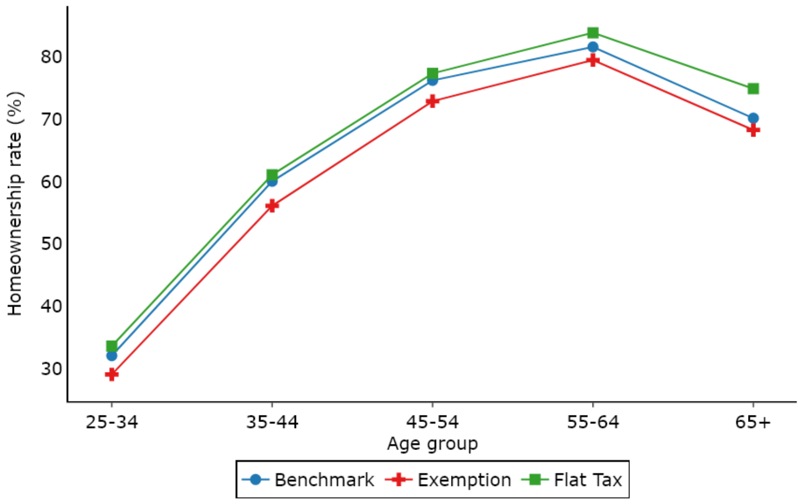


(a) Wealth deciles **(b)** Income deciles

Notes: *The figure compares homeownership rate by wealth and income decile across the benchmark and the first two counterfactuals.*

Finally, Table 4 shows the distribution of house values. Each row shows the percentage of household among homeowners who have a house valued within the range highlighted in the first column (in Thousands of Euros). Compared to the benchmark,

Figure 8: Homeownership Rate by Age Groups



Notes: *The figure compares homeownership rate by age group across the benchmark and the first two counterfactuals.*

in the first counterfactual we see an increase in the percentage of homeowners with houses valued at 200 Thousand Euros or more. This is mainly driven by the regressivity of the property tax schedule that encourages the purchase of larger house. However, as we move to a flat property tax in the second counterfactual, the share of homeowners with houses with a market value above 200 Thousand Euros decrease sharply.

Table 4: Distribution of House Values

Range	Bench	Exemption	Flat Tax
0-100	4.7	3.6	6.5
100-200	65.1	64.1	70.4
200-300	24.8	27.5	20.4
300-400	4.9	4.0	2.6
400-500	0.5	0.6	0.3

Notes: *The table compares the percentage of homeowners that have a house with a value with the range highlighted in the first column, in Thousand of Euros across the benchmark and the first two counterfactuals.*

From these policy experiment we can conclude that firstly, a large increase in government revenue can be obtained by removing the owner-occupied exemption. Nonetheless, it is important to note that taxing properties within the current cadastral system can lead to a reduction in homeownership, and an increase of wealth inequality. This is mainly due to the fact that poorer households do not manage to purchase their home, as tax rates on small houses are relatively high. However, by accompanying the removal of the exemption with the adjustment to the cadastral value, taxing properties with a proportional tax rate, we obtain a similar-sized increase in property tax revenue, without the loss of homeownership. The mechanism behind these results are driven by the changes in prices and the changes in effective property taxes, which enable poorer households to purchase houses and encourages the purchase of smaller houses. Can progressive property taxes improve these results?

4.2 Progressive Property Taxation

For the next two counterfactuals, I introduce progressive property taxes that apply to the entire housing unit owned by the household. The first counterfactual uses a more progressive schedule, while the second a less progressive one. To achieve this, I model the property taxes with the same two parameter functional form used for income taxation:

$$\bar{\mathcal{T}}(ph) = 1 - \bar{\lambda}_0 ph^{-\bar{\lambda}_1},$$

where ph is the market value of the property being taxed, $\bar{\lambda}_0$ is the level of the property tax function, and $\bar{\lambda}_1$ is the progressivity parameter. Total property taxes due are given by $ph \times \bar{\mathcal{T}}(ph)$. I assign values to the two parameters of the property tax function by exploiting the definition of a progressivity metric called progressivity tax wedge:

$$PW(v_1, v_2) = 1 - \frac{1 - \bar{\mathcal{T}}(v_2)}{1 - \bar{\mathcal{T}}(v_1)} = 1 - \left(\frac{v_1}{v_2}\right)^{\bar{\lambda}_1},$$

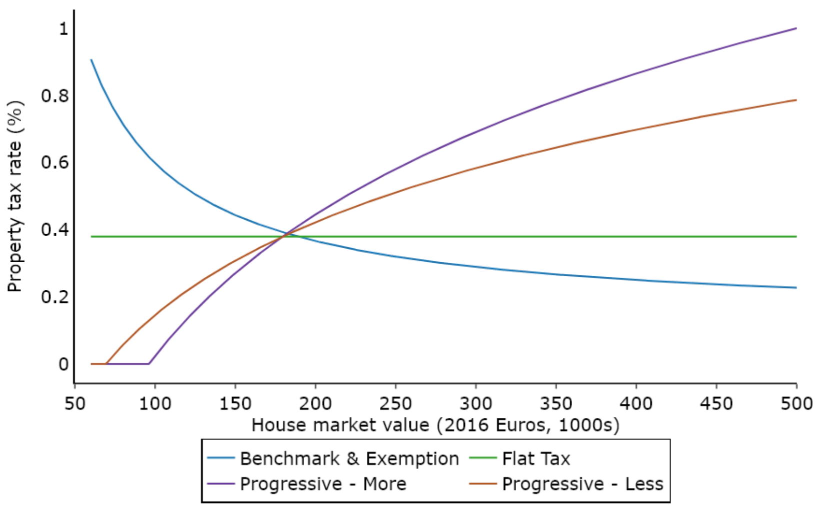
with v_1 and v_2 being arbitrary house values and $v_1 < v_2$ (Guvenen et al., 2014, Holter et al., 2019). The progressivity tax wedge gives a measure of how strongly the tax rate changes between v_1 and v_2.

For the first version of the counterfactual I choose v_1 to be approximately the median house value in Thousands of Euros in the benchmark economy, $v_1 = 180$, and v_2 to be the maximum house value, $v_2 = 500$. Then, I set the property tax rate for the median house to be $\bar{\mathcal{T}}(v_1) = 0.38\%$, in line with the national property tax rate adjusted by the average market to cadastral ratio. Meanwhile, I set the property tax rate of the largest house to be $\bar{\mathcal{T}}(v_2) = 1\%$. This gives a progressivity parameter $\bar{\lambda}_1 = 0.0061$.

Given the chosen property tax rates for v_1 and v_2, and the progressivity parameter, the level parameter has to be $\bar{\lambda}_0 = 1.0725$ for $\bar{\mathcal{T}}(v_1) = 0.38\%$. By using this two parameter functional form, negative tax rates occur for low values. I have set these to 0 in order to avoid paying out subsidies.

For the less progressive version I reduce the progressivity of the property taxation function. I do this by lowering the progressivity parameter from $\bar{\lambda}_1 = 0.0061$ to $\bar{\lambda}_1 = 0.0040$, and changing the level parameter to make sure that the median house pays the same amount of property tax rate, obtaining $\bar{\lambda}_0 = 1.0456$. As it can be seen in Figure 9, which represents the property tax rates in the benchmark and the four counterfactuals, the effective property tax rate function for the less progressive version of this counterfactual is a clockwise rotation pinned on the median value of the effective property tax rate function of the more progressive version.

Figure 9: Property Tax Rate in Benchmark and Counterfactuals



Notes: *The figure depicts the property tax rate for different market value properties for the benchmark and the four counterfactuals.*

Table 5 shows the main outcomes of interest for the two progressive property taxation counterfactuals. These amplify the main conclusions found in the second counterfactual. As property tax rate on small houses reduces even further, while tax rate on large houses increases, the demand for large houses decreases pushing down the per unit price, and more households can afford small houses. Indeed, we can see that in both in the more progressive and less progressive counterfactual, the house price falls drastically, by approximately 10 percent, and overall homeownership increases above 70%. The increase in property tax revenues in the less progressive version of the counterfactual is even higher than the one observed in the main reforms (0.99% of GDP, compared to approximately 0.9% of GDP in the main reforms).

Table 5: Progressive Property Taxes Reform

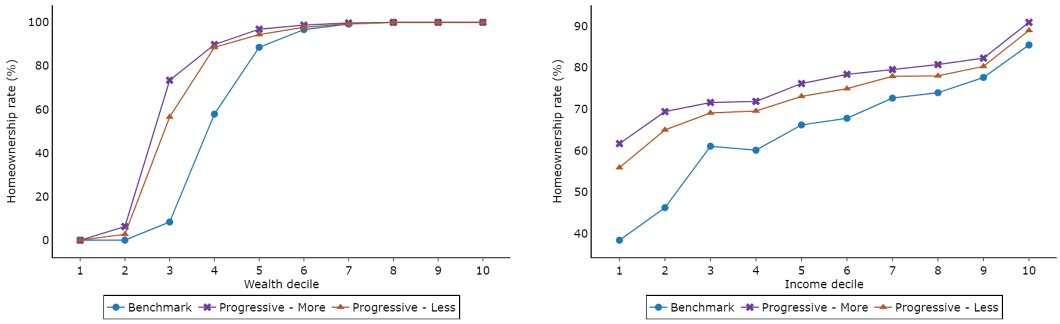
	Bench	More Progressive	Less Progressive
Price	1.0	0.901	0.913
Homeownership Rate	65.0	76.3	73.3
Wealth	194.4	199.4	198.3
Real Estate Wealth	115.5	108.9	108.1
% of Owner with Mortgage	12.3	12.6	11.9
Tax Revenue as % of GDP	0.03	0.74	0.99
Gini (Wealth)	0.486	0.47	0.475

Notes: *The table compares the main outcomes of interest across the benchmark and the last two counterfactuals. The counterfactuals are tax revenue neutral, obtained by changing the level of the income taxes. Both counterfactuals remove the owner-occupied exemption. The first uses a more progressive property tax rate, the second a less progressive one.*

Regarding wealth distribution, the overall level of wealth inequality measured by the Gini coefficient drops substantially more compared to the Flat Tax policy analyzed previously. The benchmark Gini coefficient of 0.486 drops to 0.483 in the Flat Tax reform, while it drops to 0.47 in the More Progressive counterfactual, and 0.475 in the Less Progressive. Furthermore, by looking at homeownership by wealth decile in Figure 10a we can see a larger increase in homeownership rate across the third to fifth wealth decile compared to the Flat Tax counterfactual. For the third decile homeownership rate passes from 10% to more than 40%, while for the fourth decile it goes from 58% to 88% in the More Progressive version and 77% in the Less Progressive one. Regarding the income distribution, we can observe that the progressive property taxes increase homeownership especially among households in the lowest deciles.

These two policy experiments show that a progressive property taxation system has the potential to generate large government revenues, and to increase homeownership rates. Nonetheless, a system that is *too* progressive can lead to a lower increase in property tax revenue. Furthermore, house prices decrease a great deal as demand for large houses composed of many housing units falls.

Figure 10: Homeownership Rate by Deciles



(a) Wealth deciles **(b)** Income deciles

Notes: *The figure compares homeownership rate by wealth and income decile across the benchmark and the progressive property taxation counterfactuals.*

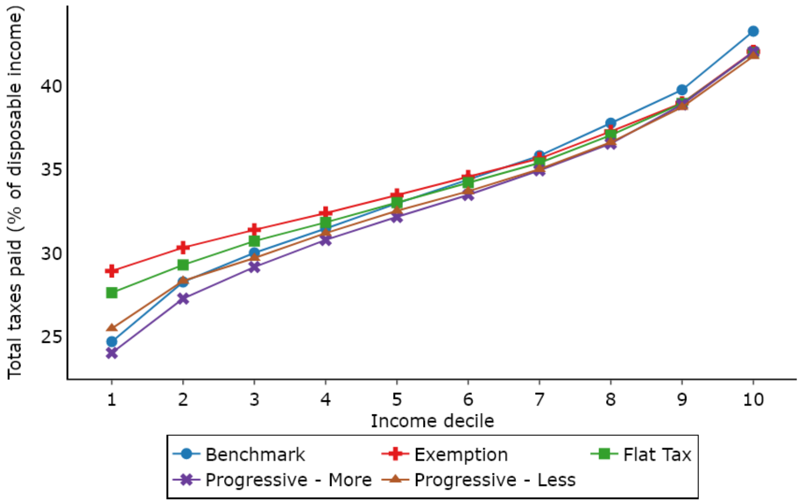
4.3 Overall Tax Progressivity

The model features two types of taxes: taxes on income and taxes on properties. In the benchmark economy, taxes on properties are negligible, hence the overall tax system is progressive, due to the progressivity of the income taxation. This can be seen in Figure 11, which shows total taxes paid as a percentage of disposable income by income decile. Households in the first income decile pay around 25% of their disposable income on taxes while households in the last income decile pay around 44%.

By taxing properties in the counterfactuals overall taxes become less progressive, except for the experiment with the more progressive property tax rate. This can be seen from Figure 11. Compared to the benchmark, households in the low income decile are paying a larger percentage of their disposable income, while households in higher income deciles are paying a lower percentage. Two aspects explain this result. First, for a given property, the increase in property taxes due to the policies are a higher burden on the disposable income of low income household compared to the high income ones. Second, the method used to obtain tax revenue neutrality, i.e., a downward shift of the marginal income tax rate, benefits households across all income levels..

A different method of achieving revenue neutrality could avoid a less progressive taxation system. For instance, rather than lowering the income taxation level, a transfer could be given to households. The size of this transfer could depend on the income decile. Alternatively, by changing the progressivity parameter of the income tax rather than the level, it is possible to achieve the desired level of tax progressivity.

Figure 11: Progressivity of Taxation



Notes: *The figure compares the total taxes paid as a percentage of household disposable income by income decile in the benchmark and five counterfactual policies.*

5 Welfare

Finally, I compare welfare implications of the policies. Welfare changes are defined by consumption equivalent variation from the benchmark economy. I compare welfare changes in the long run, i.e., across steady states, and in the short run. For the long run, I compare welfare changes for newborns after drawing the first income realization. This is done in order to show how welfare changes are heterogeneous across income groups. For the short run, I compute the welfare change for households that are alive at the time of the reform. To do this, I obtain the transition dynamics from the benchmark to the new steady state. The welfare change for counterfactual c and income i at time t is given by:

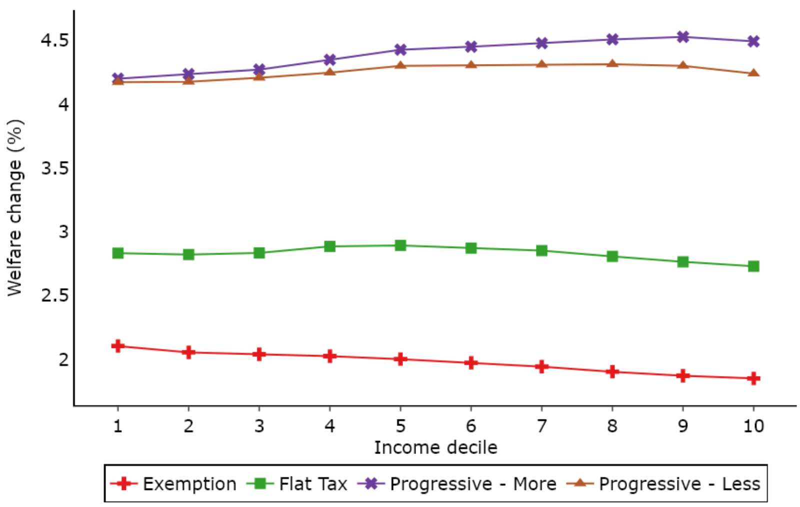
$$Welfare\ Change^{c}_{i,t} = 100 \times \left(\left(\frac{V^{c}(j,i,a,h)_t}{V^{b}(j,i,a,h)} \right)^{1/\zeta(1-\sigma)} - 1 \right), \tag{15}$$

where $V^{c}(j,i,a,h)_t$ is the value function, as defined in Equation (3), obtained in the counterfactual c at time $t \in [0,1,...,\infty)$, where the reform took place in time $t = 1$ and

$t = \infty$ represents the new steady state. Instead, $V^b()$ is the value function obtained in the benchmark economy. Finally, ζ and σ are the household's expenditure share of consumption and the degree of relative risk aversion, respectively. For the long run comparison, I focus on a newborn household ($j = 1$), that had income realization i, and has no wealth nor housing ($a = h = 0$) in the new steady-state ($t = \infty$). For the short run analysis, I compare the value function of all households across the state-space between the benchmark and the year of the reform ($t = 1$).

Figure 12 shows the long run welfare changes across counterfactuals. For all counterfactuals welfare improves: from around 1.97% improvement in the first counterfactual to 4.3% in the fourth counterfactual. Whereas the welfare changes are positive across all income deciles, newborns that drew a higher income realization have a lower welfare gains, except for the more progressive version of the fourth counterfactual. It is not an obvious conclusion that increasing property taxation, hence the user cost of owning a house, should lead to higher welfare. This is particularly true considering that in the model labour is inelastic. In order to analyze this aspect further, one can decompose the different effects of changes in housing taxation on welfare.

Figure 12: Welfare Changes Across Counterfactuals



Notes: *The figure shows the long run welfare change between the benchmark and the different counterfactuals.*

The policy experiments affect welfare through three different channels: homeownership rate, house prices, and income taxation. Firstly, as discussed in the counterfactual section, increasing property taxes increases the user cost of owning a house, and hence discourages homeownership. In this model, a lower homeownership affects welfare in two ways. First, it increases the monitoring costs that households need to pay to the real-estate agents. Second, it lowers the amount of transaction costs due to housing purchases.[23]

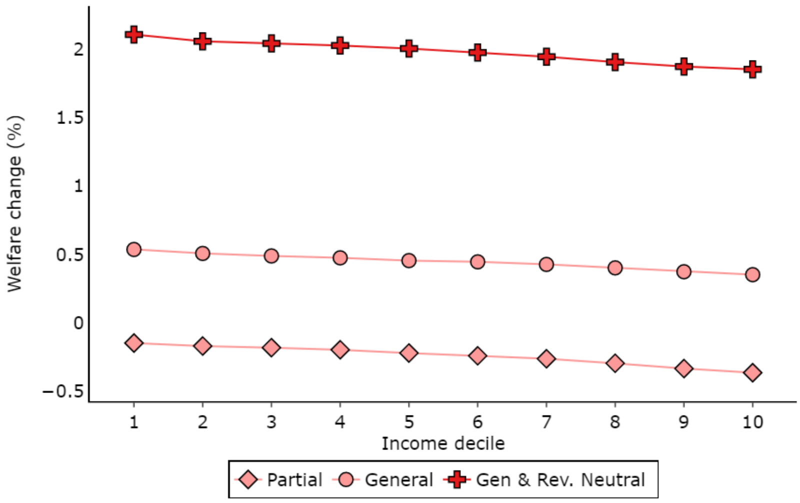
The second channel is through changes in house prices. Lower house prices reduce the cost of housing services and hence increase consumption. Furthermore, considering the fact that there is the down-payment constraint and the that there is a minimum house size that can be purchased, lower prices enable poorer households who were previously constraint to purchase a house. Regarding this point, in the flat tax and the progressive counterfactuals, the increase in homeownership is driven by households in the third to fifth wealth decile. Finally, as all the counterfactuals are tax revenue neutral, there is a shift from taxing income to taxing houses.

In order to highlight the importance of these different channels in affecting welfare, I compare the benchmark to the counterfactuals across three different steady-state equilibria. The first comparison is with partial equilibrium. Thus, the counterfactual policy applies, but house prices and rents are not changed. The second comparison is with general equilibrium, i.e., house prices can change, but without tax revenue neutrality. Finally, the benchmark is compared to the counterfactual in general equilibrium with tax revenue neutrality. This last equilibria is the one adopted for the results analyzed in previous sections. Figure 13 shows the welfare comparison across the different equilibrium for the first counterfactual, Exemption. A similar picture emerges from the other counterfactuals.

From Figure 13 it is possible to see that when only the the owner-occupied exemption is removed, and house prices do not adjust, the welfare in the new steady-state drops. The counterfactual policy increases the user cost of owning a house. Furthermore, we can see that the welfare drop is higher for the households that are born in high income deciles, as they are more likely to buy larger houses and hence pay a larger property tax. However, when we move to the second steady-state setting, where house prices can adjust, we observe that welfare improves for all income deciles. Finally, in the last setting, with both changes in prices and tax revenue neutrality, welfare improves even

[23]The second channel also depends on the number of transactions that occur. If a lower homeownership rate leads to a lower number of home transactions, this could further lower the welfare loss due to transaction costs.

Figure 13: Welfare Changes across Different Steady-States - Exemption



Notes: *The figure shows the long run welfare change between the benchmark and the first counterfactual (Exemption) across different steady state. The partial steady state occurs when the reform takes places, but prices do not adjust. The General steady state occurs when prices change, but the policy is not revenue neutral. Finally, the General and Revenue Neutral steady state occurs when prices changes and the policy is revenue neutral.*

more, as households have higher disposable incomes.

These results suggest that the long run welfare improvement of the counterfactual is driven by the reduction in equilibrium prices and an increase in disposable income. Lower house prices reduce housing services cost. Furthermore, they allow more households, especially the low wealth ones, to purchase their house and avoid paying the monitoring costs. These results have been highlighted in the literature, for example in Balke et al. (2025).

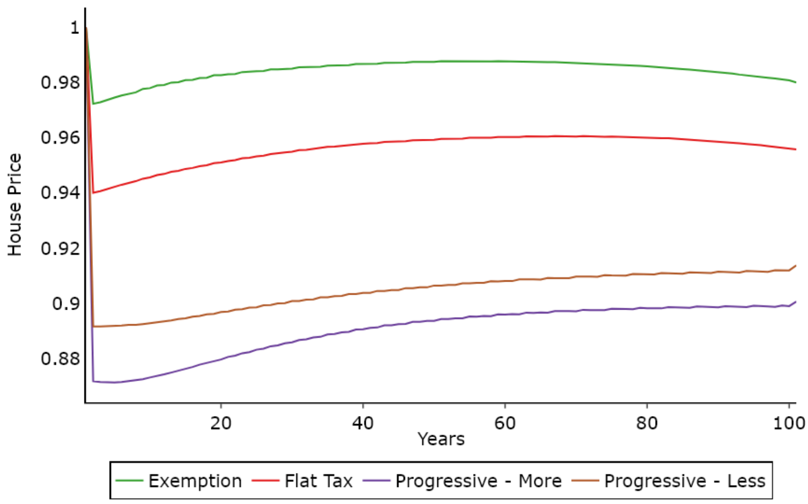
The long run welfare improvements are not mirrored in the short run analysis. Table 6 shows the short run welfare change and the percentage of winners from the reform across age groups for each counterfactual. Overall, the welfare of the households who are alive at the time of the reform drops by around 3%. The table shows the heterogenous effects of the reform across age groups: younger cohorts benefits, while older ones lose. This can also be seen from the percentage of winners. Whereas across the entire population the winners are less than a quarter, among the youngest cohorts is more than two thirds. These results are given by the large initial drop of house prices, which lowers the wealth of households that own properties - Figure 14. Among the policies analyzed, the one that leads to the lowest welfare drop is the More Progressive counterfactual. It is the policy that leads to both the largest drop in house prices, and also the highest increase in homeownership. This suggests that the increase in homeownership can mitigate the negative effects of lower house prices on existing homeowners.

Table 6: Short Run Welfare Analysis

Counterfactual		All	25-34	35-44	45-54	55-64	65+
Exemption	Welfare Change	-3.3	0.2	-1.0	-2.4	-4.3	-6.2
	% of Winners	14.9	67.1	21.7	0.9	0.0	0.0
Flat Tax	Welfare Change	-3.2	0.8	-0.8	-2.4	-4.4	-6.4
	% of Winners	19.6	68.0	39.6	4.5	0.0	2.7
Progressive More	Welfare Change	-3.1	1.9	-0.3	-2.4	-4.7	-6.6
	% of Winners	24.3	71.4	40.1	23.8	1.6	4.4
Progressive Less	Welfare Change	-3.2	1.5	-0.5	-2.5	-4.7	-6.6
	% of Winners	23.5	68.9	40.0	23.1	1.0	3.9

Notes: *The table compares the welfare change as defined in Equation (15) between the benchmark economy and the value function immediately after the reform takes place.*

Figure 14: House Prices Along the Transition



Notes: *The figure shows the house unit prices for the different counterfactuals along the transition between steady states.*

6 Conclusions

Property taxes in many countries exclude owner-occupied housing from their base. Another widespread issue with property taxes is the use of outdated cadastral values that no longer reflect market prices. Such practices can create inequities whereby properties with similar market values face different tax burdens. Moreover, empirical evidence shows that effective property tax rates are frequently higher for lower-value properties, resulting in regressive taxation

In this paper I quantitatively assess the effects of removing the owner-occupied exemption on the homeownership structure and the government tax revenues. Furthermore, I study the effects of complementing this policy with the adjustment of the cadastral values to the market values. The adjustment of these cadastral value to market value can be interpreted as analysing the effects of switching from a regressive property tax, to a proportional one. Finally, I extend the analysis by studying the implications of introducing progressive property tax schedules. Italy serves as the case study for this analysis. Because of the owner-occupied exemption, the Italian government forgoes property tax revenues from 65% of households. Furthermore, I show that due to the use of outdated cadastral values, the Italian property tax rate is de facto regressive, as higher-value homes tend to have relatively lower cadastral assessments.

I find that fully removing the owner-occupied exemption would increase property tax revenues by about 0.89 percentage points of GDP, but it would also lead to a decline in homeownership. However, the government can offset this reduction by combining the reform with an adjustment of cadastral values to market values, i.e., by taxing properties with a proportional rate.Furthermore, I show that with a progressive property tax system, the homeownership rate increases even further, yet house prices fall significantly. This increase in homeownership is driven by a reduction in house prices, which enables more households to become homeowners. More precisely, the higher taxes of large houses reduces demand for housing units, dropping the house price. This drop in price, together with the lower taxes on small houses, enables households in the bottom deciles of the wealth distribution to purchase a small house, boosting the overall homeownership rate. Finally, I show that these counterfactual policies are welfare improving in the long run, but in the short run there are heterogenous results. Young households who are alive at the time of the reform benefit, while the welfare of older ones falls. As a result, the majority of households would not support such reforms, making their political implementation challenging.

The paper abstracts from several important features. Firstly, I do not discuss methods to achieve the political feasibility of the policies I analyze, for instance compensating the losers of the policies. The paper highlights that removing the owner-occupied exemption has very large electoral costs and any government would find it hard to justify this policy. Second, the model treats the entire housing market as a single market, with no regional or urban-rural separation. Adding this aspect would lead to a more complicated model, but it could be used to analyze the migration trends present.

Appendix

A Information on Data Used

This appendix provides a description of the data used for the statistics on homeownership throughout the paper. Furthermore, it provides additional information on the homeownership setting in Italy.

SHIW

The Survey on Household Income and Wealth (SHIW) is a survey that started from 1965 with the aim of collecting data on the demographic and socio-economic characteristics of Italian households. From 1987, the survey is conducted every other year, except for a three year gap between 1995 and 1998. The survey unit is the household, that is characterized by the group of people that live in the same dwelling and that are related by either blood, marriage or adoption. The survey has information on the household components, their education, the occupational history of the household's adults, and information on household incomes, wealth and housing conditions. I reduce the household to the reference person who is defined as the person responsible for the household budget. All prices have been converted into 2016 Euros using the deflators provided by the survey or by the OECD. The sample size for each wave is of approximately 8000 households. I use the SHIW in three circumstances: computing statistics on homeownership for 2016, computing statistics on transfers for 2002, and calibrating two parameters for the period 1995-2016.

Statistics for 2016

Homeowners are defined as households that live in a dwelling that they own. I do not classify as homeowners households that live in a dwelling for which they have right of redemption. Households own a dwelling if they own 25% or more of it. Wealth is defined as the addition of real assets and financial assets, minus any financial liability. The separation on quintiles (wealth and income) is done according to the variable provided in the survey. All statistics are obtained by weighting observations according to the weights given in the survey.

Statistics for 1995-2016

The SHIW provides information on consumption and rent, which I used to obtain the consumption share. I used data on households that pay rent and homeowners that obtain rent. Furthermore, I have used information on real estate value that households own to obtain the 10th and 90th percentile of the distribution of house values needed for the calibration.

Statistics for 2002

Whereas each survey wave contains information on the mode of acquisition of the properties that household own, such as purchased it or inherited it, only the 1991 and 2002 waves contain a special module with information on all types of bequests and gifts obtained throughout the life-time (Cannari and D'Alessio, 2008). Following Cannari and D'Alessio (2008) the bequest data has been merged to the property data. This has been done to account for the fact that some households claimed not to have had transfers in the special module, yet stated that they inherited the property they owned. Values of transfers have been deflated to 2016 Euros using the OECD CPI deflators.

EU-SILC

European Union Statistics on Income and Living Conditions (EU-SILC) is a survey that started from 2004 with the aim of collecting in a standardized manner information on demographic and socio-economic characteristics, and income of several EU countries. It is conducted every year and it has a rotational design that creates both a cross-country survey and a panel survey. The panel dimension lasts four years. I use panel waves between 2007 and 2012 only for Italy to estimate income processes and tax functions. The Italian sample size for the longitudinal 2012 wave is around 5500 households.

EU-SILC provides information on total gross and net household income which has been used to estimate the tax function. This total income includes labour income, benefits or losses from self-employment, pensions, social security benefits, and income from capital or rents. Instead, to estimate the income processes I have used information on just labour income.

Cadastral Values and Market Values

I combine three different sources of data for 2016, all obtained from the Italian Tax Agency, and construct a municipal level dataset of market and cadastral values.

First, I use the Quotation Database of the Real Estate Market Observatory (*Banca Dati Quotazioni dell'Osservatorio del Mercato Immobiliare*). This dataset must be requested from the Italian Tax Agency. The dataset contains information on minimum and maximum estimated market prices per square meter within micro-areas called *Zone OMI*. The agency created the micro-areas as a continuous portion of the municipal territory that are in the same local housing market, and present uniform economic and socio-environmental conditions. For each micro-area, and for several dwelling type, the agency estimates the minimum and maximum market price for every semester by using transaction data and modelling techniques.

I use the market price estimates for the first and second semester of 2016. I only use estimates for civil houses, as this is the focus of the main analysis, that have been classified as having been maintained *Normally*. I then obtain the mean price per micro-area per semester as the simple average between the minimum and maximum price reported. I obtain the average price per square meter per micro-area for 2016 as the mean of the prices for first and second semester. Finally, I obtain the price per square meter at municipal level by averaging the price across all the micro-areas within a municipality. I compute a weighted average, with the weight given by the area of each micro-area. The tax agency provides both the information on the area of the micro-areas, and on the municipality they belong to.

Second, as the estimated prices are computed in terms of square meters, I had to multiply these estimates by a measure of the average square meters. I used information at the provincial level of total numbers of civil houses (cadastral type A2) present and total estimated amount of area covered by these. Hence, I assume that each municipality within a province has the same average square meters. This data is publicly available and can be obtained from the adjoined tables of the tax agency urban cadastral statistics report for 2016.

Finally, I constructed the average cadastral values at the municipal level. To do this, I exploited the fact that the cadastral values are obtained by multiplying the *cadastral rent* of a property by the *coefficient of revaluation* and a *cadastral multiplier*. The *cadastral rent* is a measure associated with the theoretical income that can be obtained from a property. This depends on the characteristics of the dwelling (location, size, floor) or the land. The calculations to obtain this theoretical income have not been updated from the late 80s. The *coefficient of revaluation* is an arbitrary multiplier that has been implemented from 1997. This multiplier is the same for all properties. It takes a value of 1.05 for dwellings. The *cadastral multipliers* depend on the cadastral type (i.e. residences, offices, shops and so on and so forth) and use of the property. The idea behind the cadastral multiplier is to convert the measure of income derived from the property (the *cadastral rent*) to a measure of the value of a property. Hence, the cadastral multiplier can be thought of as the inverse of a capitalization rate (Guerrieri, 2013). For main residences, the type I focus on for the analysis, the post-2012 reform cadastral multiplier is 160.

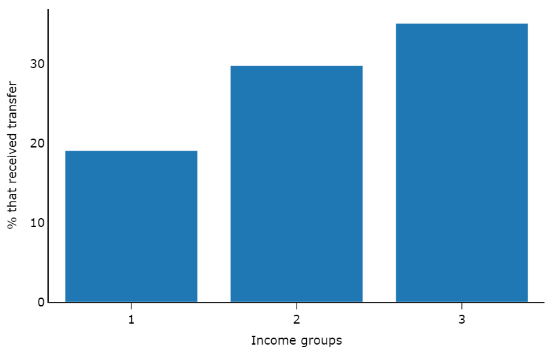
Considering this, I requested information from the Tax Agency on the average cadastral rents at the municipal level for private houses in 2016. Also in this case I focused on civil houses (cadastral type A2). I multiplied the cadastral rents by 160 (the cadastral multiplier) and by 1.05 (the revaluation coefficient) to obtain the cadastral value.

B Details on Calibration

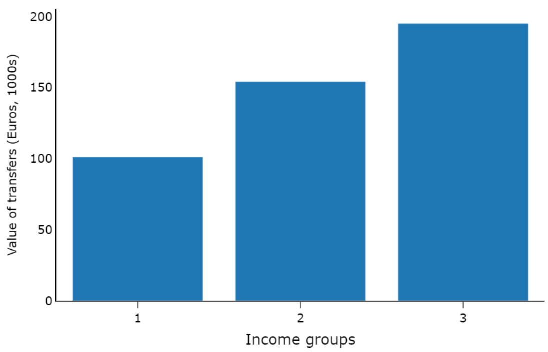
B.1 Transfers and Inheritance

Information on transfers for Italian households can be found in the 2002 wave of the SHIW, as only this wave contains complete information on all types of transfers. As only half of the 2002 wave respondents were asked to participate in the transfer module, the sample for the analysis is small. Thus, rather than using income deciles, I use three larger groups: Low (first three decile), Medium (fourth to seventh decile), and High (eight to last decile). Figure B1 shows information on transfers obtained by households whose head is between 25 and 44 years of age across income groups. The left panel shows the fraction of households in an income group that obtained a transfer, while the right panel shows the average value of the transfer in Thousands of 2016 Euros.

Figure B1: Transfers by Income Groups



(a) Fractions who received transfers



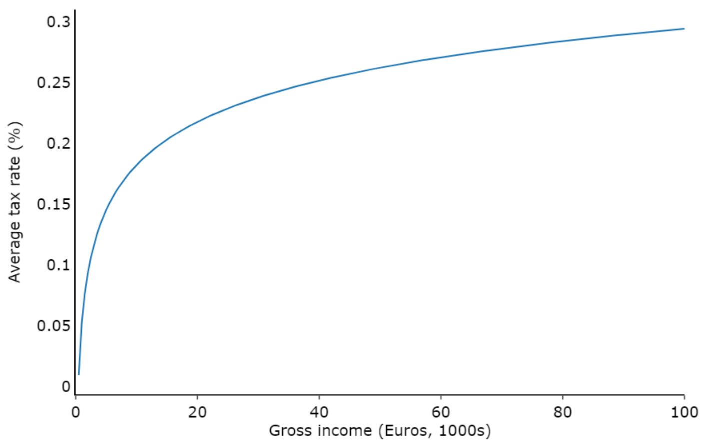
(b) Value of transfers

Notes: *The figure shows transfers received by household whose household head is between the ages of 25 and 44 across income groups. The left panel shows the fraction, while the one on the right on the mean value in 2016 Thousands of Euros, both of the transfer and across the entire group population. Source: SHIW, 2002 wave.*

B.2 Estimated Tax Function

Figure B2 shows the estimated average tax rate across gross income levels. The average tax rate I obtained from the estimated tax function are below the average tax rate reported by Baldini (2021). In his simulation he uses a representative taxpayer who is a single employee, whereas I estimate the tax function for entire families.

Figure B2: Average tax rate



Notes: *The figure depicts the average tax rate used in the model. The income taxation has been estimated by using the two parameter functional form and EU-SILC data.*

B.3 Cadastral and Market Values

The difference and relationship between cadastral value and market value is important for the analysis I conduct for two reasons. First, to determine the effective property tax rate for a given market value (Equation 14). Second, to show that the property tax system is regressive. Regarding the former, Table B1 shows the regression of cadastral value (dependent variable) on market value (independent variable). I present several specification that differ in the sample size and in the use of fixed effects. I use the third specification to estimate the effective property tax rate, yet no qualitative change would occur by selecting another one. Regarding the regressivity of the property tax system, notice that all specifications of Table B1 point to a regressive system: a constant significantly different than 0 and the coefficient on the market value variable significantly positive. These estimates imply a system that features inequity and regressivity as market values increase faster than cadastral value, meaning that expensive houses have a relatively lower cadastral value Festa and Ghiraldo (2014). While not shown here, results using other methods suggested by the literature to identify inequity and regressivity of a property tax system also indicate a regressive system (Paglin and Fogarty, 1972, Kochin and Parks, 1982, Bell, 1984).

Table B1: Regression of Cadastral Value on Market Value

	(1)	(2)	(3)	(4)	(5)
Market Value	0.215***	0.204***	0.172***	0.150***	0.166***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	54695.7***	55962.1***	59512.3***	57747.7***	60963.2***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	7366	7341	7098	7098	7098
R^2	0.229	0.189	0.132	0.513	0.228
Province FE	No	No	No	Yes	No
Region FE	No	No	No	No	Yes

Notes: *The table shows the estimated coefficients of the regression of cadastral value on market value. I present 5 specifications: The first column uses all the range of market and cadastral value, the second limits both the market and cadastral to 500.000 Euros. The third to the fifth column limit sample of the market and cadastral value between the first and ninety-ninth percentile. The fourth and fifth column are estimated using Province and Region Fixed Effects, respectively. The p-values in parentheses. Robust S.E. used. * p<0.10, ** p<0.05, *** p<0.01.*

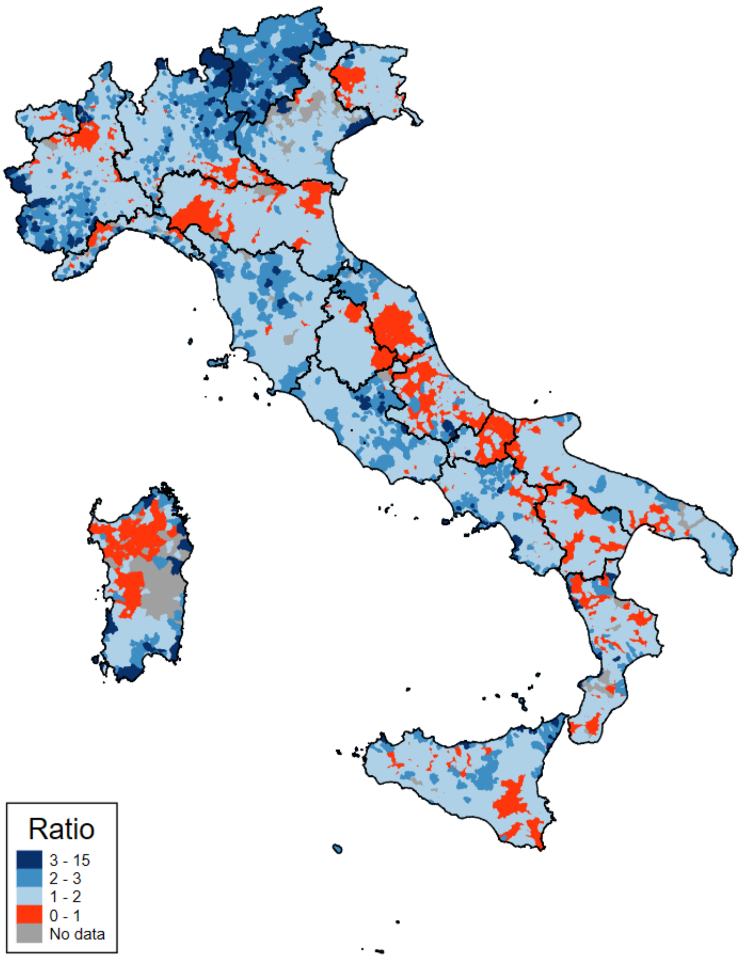
Figure B3 shows the ratio of market value over cadastral value for each municipality across Italy. Municipalities in red have a ratio that is below one. Hence, in these municipalities the taxable value is larger than the actual value of the property. A darker blue implies a higher ratio, i.e., a lower capability of the taxable value to capture the actual value. Interestingly, the North-South divide that characterizes Italy across many dimensions is not present. Indeed, one of the main determinants of the ratio is the change in local house prices in the last 30 years (Guerrieri, 2013). As the cadastral rents are based on market values of the 80s, localities that faced a large increase in house prices have a high ratio, while localities with a low or negative price growth can have ratios even below one.

B.4 Property Tax System in Italy

Figure B4 shows the total revenues from property taxes (on land, buildings and other structures), as absolute values (right axis) and as a percentage of GDP (left axis). Since 2012, the government has collected around 1% of GDP, comparable to other advanced economies.[24] Before the 2012 reform, tax collection was about half of what it is today.

[24]Spain also collects around 1% of GDP. France and the United Kingdom collect more, 2.7% and 3% respectively. Germany collects less, 0.5%. The OECD average is around 1% of GDP (2016)

Figure B3: Market to Cadastral Value Ratio Across Municipalities

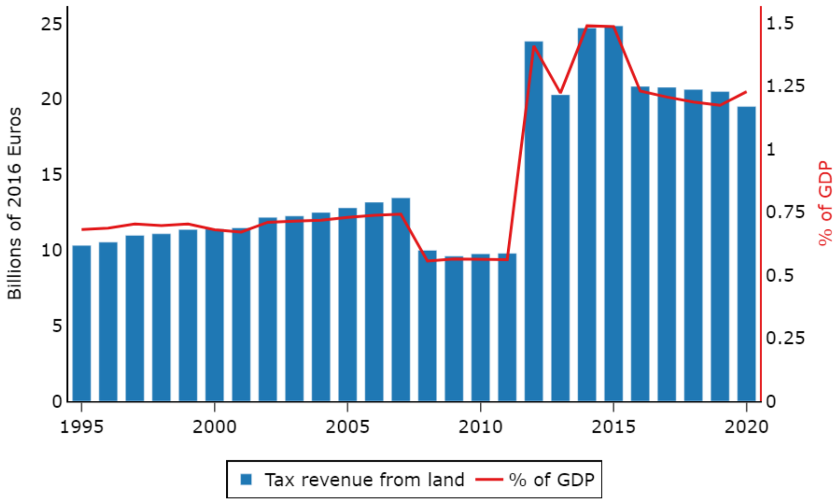


Notes: *The figure shows the market to cadastral value ratio across municipalities. The data is obtained through the combination of different sources of data provided by the Italian Tax Agency.*

As stated in the main text, the model's prediction on tax revenue does not reflect the data from Figure B4. The reason for this divergence is the fact that the data shows total revenue collection from ownership of land, buildings, and other structures by any kind of legal entity. Meanwhile, the model shows tax revenue collected from people, focusing on main houses and rented houses. In order to obtain a comparable measure of tax revenue collection from the data, I start from cadastral information and perform a series of calculations described below.

Table B2 shows the cadastral rents by type and use of dwelling for 2016. As described in Appendix A, the cadastral rent is a measure associated with the theoretical income

Figure B4: Total Revenues from Taxes on Land, Buildings and Other Structures



Notes: *The figure shows the total tax revenue from land, buildings and other structures collected by the Italian government between 1995 and 2019. The bars represent the amount collected in current Euros, and refer to the left vertical axis. The line represents the amount collected as percentage of current GDP, and refer to the right vertical axis. Source: OECD.*

that can be obtained from a property, and it is the base value used to construct the cadastral values. Firstly, it is possible to see that the total value of cadastral rents of residences (16.89 billion) is less than half of the total value of overall cadastral rent (36.80 billion). Secondly, the total value of cadastral rents of legal persons (real estate firms in the model) is similar to the total value of rented residences by natural persons. Thirdly, among the total value of cadastral rents of residences of natural persons (15.57 billion), the main residences makes up the majority of the value. The second largest component is Other, which is made up of secondary or empty houses, and is not included in the model. Rented makes up the smallest part of the value.

From this data one can obtain an approximate measure of property tax revenue in two steps. First, calculate the total cadastral value of rented residences by multiplying the cadastral rents of rented residences (1.56 billion) by 1.05 and 160, the multiplier. Second, apply to this value the national property tax rate (0.76%). We obtain that property tax revenue are approximately 0.12% of the 2016 GDP. The model underestimates the property tax revenues as % of GDP obtained in this manner (0.03%), yet the estimates are comparable. By applying similar calculations to the cadastral rent for main residences, we obtain that by removing the owner-occupied exemption the tax revenue should increase by approximately 14 Billion Euros.

Table B2: Cadastral Rents by Type and Use

Use/Type	Residences	Other types	Total
Natural persons	15.57	7.01	22.57
Main residences	10.77	0.00	10.77
Rented	1.56	2.62	4.17
Other uses (secondary, empty)	3.24	4.39	7.63
Legal persons	1.33	12.90	14.23
Total	16.89	19.91	36.80

Notes: *The table shows the cadastral rents in Billions of Euros by type and use across Italy for 2016. Data retrieved from Dipartimento delle Finanze (2020).*

C Counterfactual: Net of Mortgage

This counterfactual is similar to the Flat Tax reform discussed in the main text. The owner-occupied exemption is removed, and a flat property tax rate of 0.38% is applied to all properties. However, in this case, the tax base is redefined to exclude the value of mortgage. For this reason, we refer to this counterfactual as Net of Mortgage. Similarly to the counterfactuals discussed in the main text, the reform is revenue neutral, and the income tax schedule is adjusted accordingly.

Table C1 compares the several outcomes of interest between the benchmark, the Flat Tax reform, and the Net of Mortgage reform. Comparing the tax revenues from property, we can observe that the Flat Tax and the Net of Mortgage counterfactuals lead to a similar increase. Furthermore, we can observe that homeownership rate in the Net of Mortgage counterfactual is higher increases even higher than the Flat Tax reform. Finally, as expected, the percentage of homeowners with an outstanding mortgage is also higher in the last reform: 1 percentage points higher than the benchmark, and 1.5 percentage points higher than the Flat Tax counterfactual.

The increases in homeownership and mortgage uptake compared to the Flat Tax counterfactual are driven by households in the working age groups. It must be noted that given the low use of mortgages, the Italian context might not be the best one to analyze the potential of this policy. In a setting with a higher mortgage uptake the results could be even more striking.

Table C1: Main Property Taxation Reforms

	Bench	Flat Tax	Net of Mortgage
Price	1.0	0.956	0.959
Homeownership Rate	65.0	67.6	68.8
Wealth	194.4	195.7	195.3
Real Estate Wealth	115.5	112.0	114.1
% of Owner with Mortgage	12.3	11.8	13.3
Tax Revenue as % of GDP	0.03	0.9	0.89
Gini (Wealth)	0.486	0.483	0.483

Notes: *The table compares the main outcomes of interest across the benchmark and the two counterfactuals. The counterfactual are tax revenue neutral, obtained by changing the level of the income taxes. Counterfactual 1 (Flat Tax) is the removal of the owner-occupied house exemption and the adjustment of the cadastral value to match the market value. Counterfactual 2 (Net of Mortgage) adds to Flat Tax the fact that taxes apply on house value net of mortgages.*

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